Canada. Parliament. Senate. Special committee on science policy.
Proceedings

1968-69 No 15-20

First Session—Twenty-eighth Parliament

1968-69

THE SENATE OF CANADA

PROCEEDINGS OF THE SPECIAL COMMITTEE ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*

The Honourable DONALD CAMERON, *Vice-Chairman*

No. 15-20

WEDNESDAY, DECEMBER 11th, 1968

WITNESSES:

Department of Fisheries and Forestry: A. W. H. Needler, Deputy Minister, Fisheries and Forestry; M. L. Prebble, Assistant Deputy Minister (Forestry); D. R. Redmond, Scientific Advisor (Forestry).

APPENDIX

13.—Brief submitted by the Department of Fisheries and Forestry (Forestry Branch).

QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
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MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Belisle
Bourget
Cameron
Desruisseaux
Grosart
Hays
Kinnear
Lamontagne
Lang
Leonard
MacKenzie
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

WEDNESDAY, December 11th, 1968.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 10.00 a.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Belisle, Bourget, Cameron, Grosart, Kinnear, Lang, MacKenzie and Robichaud. (9)

Present but not of the Committee: The Honourable Senators Carter, Kinley and McGrand. (3)

In attendance: Philip Pocock, Director of Research (Physical Science).

The following witnesses were heard:

DEPARTMENT OF FISHERIES AND FORESTRY:

A. W. H. Needler, Deputy Minister, Fisheries and Forestry;
M. L. Prebble, Assistant Deputy Minister (Forestry); and
D. R. Redmond, Scientific Advisor (Forestry).

(*A curriculum vitae of each witness follows these Minutes.*)

The following is printed as Appendix No. 13: Brief submitted by the Department of Fisheries and Forestry.

At 12.40 p.m. the Committee adjourned until 3.30 p.m. this day.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Needler, A. W. H. Born in August, 1906, at Huntsville, Ontario. Son of George Henry Needler, former Professor of German at University of Toronto. Educated at University of Toronto Schools; Married 1st, Alfreda Alice (died 1951), daughter of C. J. Berkeley, Nanaimo, B.C., May 30, 1930; Three children: Mary, George, Edith; 2ndly, Nina M. Parker, March 20, 1953; Two children: Duncan, David; B.A. from University of Toronto, 1926; M.A. from University of Toronto, 1927; Ph.D. from University of Toronto, 1930; D.Sc. (Hon.) from University of New Brunswick, 1954; Volunteer investigator, then full-time biologist, with Fisheries Research Board in P.E.I., 1924-1929; Scientific Assistant, Fisheries Research Board, 1929-1930; Assistant Zoologist, Fisheries Research Board, 1931-1937; Associate Zoologist, Fisheries Research Board, 1937-1939; Chief Zoologist, Fisheries Research Board, 1939-1941; Director, Atlantic Biological Station, 1941-1954; Concurrently Assistant Deputy Minister, Fisheries, 1948-1950; Director, Biological Station, Nanaimo, 1954-1963; Deputy Minister, Fisheries, 1963-1968; Deputy Minister, Fisheries and Forestry, 1968. He was a member of the Committee on Fisheries Statistics, North American Council on Fisheries Investigations, 1928-1939; and Adviser to the International Passamaquoddy Fisheries Commission, 1931-1934. In 1945 he was Secretary to the Fisheries Committee, 1st FAO Conference at Quebec, and member of the Canadian delegation, 2nd FAO Conference, Copenhagen, 1946; and was Scientific Alternate Chairman, Atlantic Herring Investigation Committee, 1944-1950. He was a delegate to the Northwest Atlantic Fisheries Conference, Washington, 1949, and first Chairman of the resulting Committee on Research and Statistics, International Commission for Northwest Atlantic Fisheries, 1951-1954. He was Federal Government member,' P.E.I. Fisheries Development Committee, 1951-1955; appointed Chairman, FAO Advisory Committee on Marine Resources in 1963, also appointed Chairman, International North Pacific Fisheries Commission in 1963. In 1966, he was elected Chairman, FAO's new Committee on Fisheries. His work has covered many areas of fisheries research, such as oceanography, haddock ecology, life history and migration, fisheries statistics biological study, Atlantic oyster ecology; and has directed research on salmon, groundfish, herring and other potentially important fish of the Pacific Ocean. He was made an officer, Order of the British Empire, in recognition of his work in fisheries during World War II; and is a Fellow of the Royal Society of Canada.

Prebble, M. L.: Born June 10, 1909, at St. John, N.B.; Secondary education at St. John, N.B.; Married September 26, 1934, to Louise, daughter of Frank Nutter Chaffey of St. George, N.B. One son: James; B. Sc. in Forestry from University of New Brunswick, 1930; M. Sc. from Macdonald College (McGill University), 1932; Ph. D. from Macdonald College (McGill University), 1940; With Forest Insect Investigations Unit, Division of Entomology, Federal Dept. of Agriculture, at Fredericton with assignments in Nova Scotia, New Brunswick and Gaspé Peninsula, 1930-1940; Officer-in-Charge, Forest Insect Laboratory, Victoria, 1940-1945; Officer-in-Charge, Forest Insect Laboratory, Sault Ste. Marie, 1945-1952; Director, Forest Biology Division, Department of Agriculture, 1952-1960; Director, Entomology and Pathology Branch, Department of Forestry, 1960-1965; Assistant Deputy Minister (Forestry), 1965. Member

of Canadian Institute of Forestry, Entomological Society of America, Entomological Society of Canada, Association of Registered Professional Foresters of New Brunswick, Professional Institute of the Public Service of Canada.

Redmond, D. R.: Born August 30, 1918, in Nova Scotia; After graduation from high school, was engaged in pulp and lumber-milling operations for seven years; Served in the R.C.A.F. during World War II and was awarded the D.F.C.; B. Sc. Forestry from University of New Brunswick in 1949; Master of Forestry *cum laude,* Yale University, 1950; Ph. D., Yale University, 1954; After graduation from University of New Brunswick, conducted forest pathology research in Ontario with Canada Department of Agriculture. Later served as Nova Scotia Provincial Forest Pathologist. Officer-in-Charge of Forest Pathology investigations in the Atlantic Provinces in the Forest Biology Laboratory, Canada Department of Agriculture, Fredericton, N.B., 1951-1957. Chief of the Forest Research Division of Forestry Branch, Department of Northern Affairs and National Resources, 1957-1960. Director of the Forest Research Branch, Department of Forestry, 1960-1965. Scientific Adviser (Forestry), 1965. He served as honorary lecturer in forest pathology, University of New Brunswick, 1951-1957. He represented Canada at the first three Sessions of the North American Forestry Commission of FAO in Mexico in 1961, in Canada in 1963, and in the U.S.A. in 1965; and was Canadian delegate to the Eighth British Commonwealth Forestry Conference in East Africa, 1962; and has been a member of Permanent Committee of the International Union of Forestry Research Organizations since 1961. He was alternate delegate to the Sixth World Forestry Congress in Madrid, Spain, in 1966; served on the Joint FAO/IUFRO Committee on Bibliography and Terminology since 1966; and served the Canadian Institute of Forestry in various capacities, including two years as member of the Board of Directors. He has been a member of the Research Program Committee, Woodlands, of the Pulp and Paper Research Institute of Canada since 1960; member of the Canadian Committee of the International Biological Program; and member of the Canadian National Committee of the International Hydrological Decade. He serves in an advisory capacity on various scholarship, research and advisory panels with industry, universities, and other federal departments. He is a member of the Canadian Institute of Forestry, Canadian Phytopathological Society, Commonwealth Forestry Association, Society of American Foresters, Ontario Forestry Association, Ontario Professional Foresters Association, Sigma Xi.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Wednesday, December 11, 1968

The Special Committee on Science Policy met this day at 10.00 a.m.

Senator Maurice Lamontagne (Chairman) in the Chair.

The Chairman: Honourable senators, we have with us this morning representatives from the Department of Fisheries and Forestry and the witnesses are: Dr. A. W. H. Needler, the Deputy Minister of Fisheries and Forestry; Dr. M. L. Prebble, Assistant Deputy Minister (Forestry); Dr. D. R. Redmond, Scientific Adviser (Forestry) and Mr. A. B. Vincent, Assistant to Special and Scientific Advisers (Forestry).

The situation we are confronted with this morning is a little awkward in the federal scene, because we still have a Minister of Forestry and Rural Development, Mr. Marchand, but he has nothing to do with Forestry. We also have a Department of Fisheries, which is also now responsible for Forestry.

Dr. Needler was just telling me that he might rely on certain occasions on Dr. Prebble, because these responsibilities in so far as Forestry is concerned are relatively new to him, since they only go back to probably some time in July or August.

Without any further introduction, I would ask Dr. Needler to make a brief opening statement and then, as usual, we will have our discussion period.

Dr. A. W. H. Needler, Deputy Minister, Department of Fisheries and Forestry: Mr. Chairman, you have explained the situation very well. I do my best to become an expert in the field of Forestry, but I find that the subject is complicated enough to require more than three months of part-time work to really become an expert, so I would like to make a few very general remarks and leave to Dr. Prebble the answering of more detailed questions.

In introducing the discussion on forestry research, I should point out that the Government of Canada has conducted programs in this field of science for over 50 years. During the greater part of this extended period the forestry research programs were organized more or less on disciplinary lines and were, in fact, carried out in two different departments simultaneously.

Amalgamation of the several programs in one department was effected in 1960, when the Department of Forestry was established; and consolidation and integration occurred in the following years, resulting in the organizational structure known as the Forestry Branch.

As part of the reorganization of several departments in July, 1968, the Forestry Branch and allied supporting elements were transferred from the then Department of Forestry and Rural Development to the Department of Fisheries, the title of which it was then announced would, in due course, be changed to the Department of Fisheries and Forestry. Reorganization within the department, to take account of its enlarged sphere of activities, is now in progress.

I propose to keep these introductory comments quite brief. An extensive statement on forestry research has been submitted by officers of the Forestry Branch, following the questionnaire and guidelines prepared by the secretariat of this committee. Officers of the branch are present and will undertake to respond to the more detailed questions which you may wish to raise in relation to forestry problems and forestry research programs. However, I do wish to draw your attention to a number of features that you may wish to pursue further.

The forestry program of the department is directed towards the improvement of the forests of Canada and the well-being of the forest-based industries, which, as you are aware, are very important in the economic life of the nation and in its export trade. Since the forests of Canada, with the exception of those in the northern territories and in federal parks, military reserves and Indian reservations, belong to the provincial governments, and since industrial use of the forest resources rests with the private sector, the program of the Forestry Branch is of necessity developed and executed in very close co-operation with the provincial forestry departments and the forest industries.

The program is highly decentralized. Seven regional forest research laboratories serve the needs of individual provinces, or groups of provinces. Forest products laboratories at Ottawa and Vancouver serve the needs of the wood-using industries in eastern and western Canada respectively. And seven research institutes carry out research programs in highly specialized fields to complement and extend the programs of the other establishments, and to conduct some national programs that cannot be appropriately divided among widely dispersed establishments.

Program development in the Forestry Branch is guided by regional advisory committees in the forest research field, and by groups of industry specialists in the forest products field. Program co-ordination across all branch establishments is effected by senior specialists at branch headquarters.

Co-operation with universities is effected through several channels, including the regional advisory committees, a program of extra-mural research projects sponsored by the Forestry Branch, operating grants in support of post-graduate research at the four Canadian forestry schools, and professional service contracts with university professors.

The present level of research on forestry and forest products, amounting to about $43 million, is not considered adequate. Of this amount, industry provides 51 per cent, largely in the products field; the federal Government provides 42 per cent through the operations of the Forestry Branch; provinces provide four per cent, and universities about three per cent. With the continually growing demands on the forest lands and wood resources of the nation, for industrial uses, water production, recreation and wildlife habitat, enlarged programs of research must be provided for, to avoid serious conflicts of interest and to assure the continuing well-being of the essential forest industries.

That, Mr. Chairman, is all that I would say in introduction.

The Chairman: Thank you, Dr. Needler. We come now to questions from the committee. Senator Cameron?

Senator Cameron: Is not Dr. Prebble making a statement?

The Chairman: Would you like to add something, Dr. Prebble?

Dr. M. L. Prebble, Assistant Deputy Minister (Forestry): Mr. Chairman, I do not think it is necessary. If the members of the committee have read the synoptic statement at the front of this brief then time might be saved if I do not read it. It covers eight or nine pages, and unless you want me to read it I would think we might use the time more profitably elsewhere.

Senator Cameron: Yes. My first comment—and this is a comment rather than question—refers to paragraph 3 of the summary and main conclusions, in which you refer to the statistics for 1965 being the latest statistics. I want to emphasize that we are constantly running into this problem. The statistics that we have for present use are those for as far back as 1960 and 1961 up to 1965. We must find some way of obtaining more up to date figures, if those figures are to be meaningful in terms of statements of this kind.

May I ask how much co-operation there is with the provincial departments of forestry and the university schools of forestry? Dr. Needler has indicated that there is a great deal of it, but could he just elaborate a little bit on how this takes place?

Dr. Needler: I think I should refer this to Dr. Prebble.

Dr. Prebble: Mr. Chairman and senators, co-operation between the Forestry Branch and the provincial services, of course, is a vital part of the operational program of the Forestry Branch. This is effected through almost constant and day-to-day contacts with the provincial people, and more formally through the operation of these regional advisory committees to which Dr. Needler referred. They have been in operation now for two or three years, and they involve the

provincial forestry departments, the universities, the industry, the regional economic councils where they exist, and sometimes other departments such as the Department of Agriculture, in the review of broad problem areas, the review of current work at the present time, the assessment of priorities for new programs, and then the progress of those programs as they develop. So, the provinces, in general, have a very strong in-put into the development of programs and the monitoring of their execution. That occurs in all regions of Canada.

Only two provinces have forest research organizations—British Columbia and Ontario—and our programs are developed in very close concert with the provincial people, through both the regional advisory committees and direct contact between their organizations and ours. The purpose is to complement rather than to duplicate programs.

With respect to your question about the universities, I think the answer is partly inherent in what I have just said. University people and especially the deans of the forestry schools are involved in the regional advisory committees which review programs and problems. In addition to that we do have collaborative arrangements through our extra-mural research programs throughout Canada to which the universities contribute. The funds are provided by the Forestry Branch in its estimates for research contracts carried out by them. In addition we quite frequently engage the university professors under special contracts for maybe short term contractual projects.

Senator Cameron: I notice that you allocate $40,000 a year to four universities, and that seems to be a relatively small amount of money.

Dr. Prebble: Yes.

Senator Cameron: Is that amount of $40,000 used mainly to assist creative studies, or how is it used?

Dr. Prebble: This is the second year in which this program has been going on. I would point out that the amount is $40,000 per school. We initiated that program after quite careful discussions with the deans of the four forestry schools. What we are aiming at here is really to improve the research programs in the forestry schools at the graduate level. It is aimed at developing what you might call centres of excellence in each of the four forestry schools.

Each of the deans was asked to identify areas in which he felt his school could play a particularly important part in the development of research competence in forestry for Canada. An attempt was made, I think quite successfully, to avoid complete duplication of those programs of each of the four forestry schools. They were given a fair amount of latitude in that. The funds are used in support of graduate students, hiring of technicians, equipment, supplies, travel and things of that kind, but the programs are essentially under the control of the deans themselves. Once a year we study progress. We have it in mind to increase quite substantially those grants as the time goes on, several fold actually.

Senator Cameron: If it is $40,000 in terms of assisting graduate students and, as you say, providing equipment, technicians, and so on, it must be spread pretty thin. How many students would be involved? Have you any idea?

Dr. Prebble: I cannot quote exact figures, but at the last meeting that we had of the forestry deans they presented very good reports on the field of work being covered in these graduate research programs, the number of students and so on. These funds, of course, are supplementary to other funds already available to the deans. Without being exact, I would think the number of students who had assistance under these programs in the four schools would be close to 30 or 40 altogether, which means that the amount of support to an individual student is not great. However, they have expressed the feeling that the $40,000 per school has made a quite substantial difference in the program they are able to operate at the graduate student level. Our hope is to increase it several fold over the next few years.

Senator Cameron: I realize politically—I am speaking of inter-university politics now—

The Chairman: That is better!

Senator Grosart: It is the worse kind!

The Chairman: It is better for our witness.

Senator Cameron: If there is only $160,000 it could be argued that it would be more effectively used if it were divided between

two universities rather than four. That may be an unfair question, but I am just wondering about that.

Dr. Prebble: No, it is not an unfair question. We visualize the necessity, as time goes on, of being a little discriminating in how the additional funds are used. In other words, maybe we do not always operate on a 25 per cent basis. However, we have not met that problem yet. Some day, if the funds get very substantial, we may have to meet that problem on a quite objective basis. At present I think the funds are being used quite effectively. Of course, each of the schools would like to have more money, and we will try to meet that as time goes on.

Senator Cameron: You said there are about 40 roughly?

Dr. Prebble: Yes.

Senator Cameron: Doing graduate work?

Dr. Prebble: Under the support of this program.

Senator Cameron: Have you any idea what relation that bears to the total number of students enrolled in the forestry schools? This is not too important.

Dr. Prebble: The number getting support under these programs would be probably somewhere in the vicinity of one-third to 40 per cent of the number of graduate students in the forestry schools.

Senator Cameron: On page 89 of the brief you refer to graduate education in forestry, and I notice that only 34 per cent of the Ph.Ds in the branch received their degrees in Canada. I presume this is because we are not offering programs at this level?

Dr. Prebble: This is one of the reasons why this program was initiated, because of the fact that the bulk of our people go outside Canada to get post-graduate training, which disturbed us quite a bit.

Senator Cameron: Are you aware of any plans at the moment to offer Ph.D. programs in Canadian universities?

Dr. Prebble: There are such programs in Canada at the present time.

Senator Cameron: At U.N.B.?

Dr. Prebble: U.N.B., Toronto, U.B.C., Laval.

Senator Cameron: They have been used to some extent, but they have not been sufficiently highly specialized to encourage a great majority of the students to do their graduate training in Canada.

Senator Kinley: What about New Brunswick? They have a course in forestry. How many students do they have?

Dr. Prebble: Graduate students?

Senator Kinley: At the University of New Brunswick.

Dr. Prebble: I am afraid I did not anticipate such detailed questions, but I would imagine that at the graduate level they would probably have in the vicinity of maybe 20 students, say, plus or minus.

The Chairman: At the graduate level?

Dr. Prebble: At the graduate level, but the total enrolment would probably be closer to 160 to 200.

Senator Kinley: In forestry?

Dr. Prebble: In four years.

Senator Kinley: The number of graduates will increase.

Dr. Prebble: The number of graduate students is increasing at all four Canadian forestry schools.

Senator Kinley: I know that some are working in British Columbia now.

Senator Cameron: How soon do you anticipate an increase in the amount of funds available for this program through the Department of Forestry? Do you have, say, a five-year projection ahead?

Dr. Prebble: Yes, we do indeed, but there cannot be any increase in 1969-70 because of the limitation imposed by the budgetary situation. Our first forecast was rising to about $500,000—I believe it was—at the end of this program review period. We shall be a little slower in attaining that now because of the budgetary situation.

Senator Cameron: Apart from the number of Ph.D.s, what is the main source of your senior research people? Do you get some from Scandinavian countries?

Dr. Prebble: I think there is a table which shows this. On page 87 you will see a tabulation which gives the country of birth of our

people; on page 88 the country of secondary education is given; finally there is the table on page 89. We recruit quite heavily at the bachelor level in Canada with the expectation that people will take further academic training through an educational program sponsored by the department and concurred in by the Treasury Board.

The Chairman: How do you explain this relatively great number from India?

Dr. Prebble: I think that has a bearing on the population in India and the difficulty of finding jobs in India. A great many students come over to North America for post-graduate training and fellowships. In India the employment opportunities are not promising so they come to North America. There is a tremendous supply of people from India and we have tried to be quite selective in getting people from that group who could make a contribution to forestry.

Senator Cameron: In your organization chart on page 2 the Director of External Relations—this obviously involves relations with foreign countries. How much co-operation is there? Do you do it through meetings, conferences and so on? What kind of exchange of personnel is there?

Dr. Prebble: If you do not mind, sir, I would like Dr. Redmond to speak to this question. He has been very active in this field for several years.

Dr. D. R. Redmond (Scientific Adviser, (Forestry), Department of Fisheries and Forestry): This group on external relations is not only external to Canada, but also external to the department. I think this helps explain some of its activities. You were referring, I believe, specifically, to outside of Canada?

Senator Cameron: Yes.

Dr. Redmond: Quite a large number of the members of our staff are very active in international committees, especially between here and the United States, because of the pests of the forests and fire that do not recognize our international boundaries. We have quite a large number of pest control and other type of committees on which we are very active. I will deal with the research first if I may, sir.

The International Union of Forestry Research Organizations is a non-governmental organization or union. Membership is made up of well over 200 research institutes or agencies in well over 60 countries. Canadians are very active in this union, attending conferences and congresses on special subjects and this allows Canadians from the department, the provinces, and the universities who attend to be fully informed on developments in their specialities from around the world. There are a lot of other activities that are taken care of under this external relations program that deal with such things as the FAO agencies. The North American Forestry Commission of FAO is one of them. We are one of the three members and there are members of the department who regularly attend the annual meetings of FAO that are held in Rome.

There is the International Poplar Commission which is another agency of FAO. Canada, just this year, has been a host to the first meeting of the commission held in North America. There are a great number of other contacts through the OECD, the ECE and the ILO. I would say also that one of our very useful relationships is with the Standing Committee on Commonwealth Forestry. This committee holds Commonwealth forestry conferences at intervals of about five years. Canadians have a large input into this conference.

Senator Cameron: I have seen something of the forestry work in Norway, Sweden and Northern Germany where there is a cultivation program. How extensive is work of that kind being done in Canada?

Dr. Redmond: We have only reached the stage where we are starting to implement the type of culture and forest management that is being done in Scandinavia, West Germany and Denmark. When our people from industry, universities, etc. attend conferences in Europe they usually make a point of visiting one or two other areas to become informed of developments in which they have an intimate interest.

We have brought specialists from those countries to Canada on contract to assist in development programs. One that comes to mind immediately is the development of a program to use peat lands in Newfoundland. We have recently been assisted by the provincial government there and industry and we developed a program where we were able to bring one of the world's leading specialists on peatland forestry from Finland to Newfoundland. He has done a very careful study of the conditions there with very useful results.

Of course, there is tremendous improvement in the introduction of organisms for biological control and we have set up quite a few useful connections. As our economy allows our programs are being developed, taking into consideration what is known and the experience gained in other countries. We are not yet in need of the intensive management programs they have in other countries.

The Chairman: Why have we been so late in introducing these methods in Canada? Because we did not need them?

Dr. Redmond: Partly, sir. We have introduced a lot of methods over the years of course. Forestry in North America came from Germany. It is mainly because we do not need them. We keep abreast of developments from the point of view of research and we have people that are transferred on loan for several months to certain areas of interest and they return with knowledge that is needed for implementation, whatever the problem might be.

It is only when you can show that more wood or cheaper wood can be grown that you can really get the provinces and the industries interested in implementing these new techniques. We are reaching that stage rather rapidly and probably by the year 2000 there will be as great a need for the types of forestry here as they are now using in those other areas.

Senator Cameron: There are two points arising out of that comment that I would like to discuss. One, you referred to bringing an expert from Finland on the utilization of forestry growth in the peat moss areas. As you know a tremendous amount of the pre-Cambrian Shield is covered with a very scrubby, not very valuable—from a lumbering standpoint—kind of tree growth. What can be done or is there a useful crop to be garnered over these huge areas of Canada with new harvesting techniques? This is all small stuff as you know, or mostly small stuff, yet it covers millions of acres of Canada. What is the future of that kind of land? What is its productivity in terms of value?

Dr. Redmond: I would say that the pre-Cambrian Shield now produces most of the wood that is used in the pulp and paper industry in Eastern Canada and there are great areas of this. Although it is made up of small trees there are good yields per acre and this is where we are getting our yields today. There are still greater areas of this covered with small trees that are still productive enough to produce more wood than we are using. We are hoping to improve harvesting techniques and transportation techniques that will make it even more economical to use this wood and, of course, with improved planting, seeding and re-forestation techniques we can improve the yield by stocking the area better. By tree improvement programs, we should be able to produce better stock to grow there for the next generation.

Senator Cameron: In view of the fact that this takes up 23 or 24 per cent of our exports, do you see greater utilization of these swampy areas, the kind of thing you get from Edmonton north, but beyond the Athabaska, and that kind of country? Do you see a productive future in that kind of land?

Dr. Redmond: If it can be done economically, yes. It is a transportation problem. It is a long piece to the big markets of the land.

The Chairman: You are too far.

Senator Cameron: I am looking to the year 2000. You mentioned the question of poplar. I was trying to get poplar plywood the other day and I was told it would be cheaper to bring in Philippine plywood than use poplar. Poplar covers the whole country. Why is it in such short supply for consumption right now?

Dr. Redmond: Poplar grows in nature with the pulp and paper species and to get it out economically I think it should be cut at the same time. So that one operation does it. At the present time, there is very little cutting and harvesting of poplars along with the harvesting of pulp species. There have been plywood mills for poplar in northern Ontario but the latest information I have is that the biggest one up there has had to close, I guess for economic reasons. There is not a shortage of wood but there may be a shortage of large volumes of suitable wood for veneers in areas, though there is a lot of poplar.

Our species of poplar are mainly the aspens, which are not the same species of poplar that are used in more Southern countries, the Mississippi Valley or Italy or the Mediterranean area. These poplars are bigger and grow faster. We find they grow only on the alluvial flats and we do not have great areas of alluvial flats with poplars on them. You find this type of poplar in the Peace River Valley and the northern part of Alberta.

Senator Cameron: This brings us to one of the very controversial present day issues. You are aware, of course, of the rumpus that is going on about the logging in Algonquin Park. It seems to me that there is a fundamental principle here, or conflict between the wild life people who say one must not touch it at all and the people who say that this is not so. The foresters are saying that you can improve the forest by selective logging. This does not apply only to Algonquin Park. I live in a national park, so I hear the same story. Naturally, we want to preserve our reserves and our wild life. What is the truth of this? I have seen four television programs. The strip mining in British Columbia, supposed to be destroying the forest, as it is in some areas, and the Algonquin Park has become a very emotional issue. Beyond that, what are the facts? Can you go into a place like Algonquin Park and improve it from the standpoint of disease control, fire control, and general productivity by selective logging?

Dr. Prebble: It is an emotional issue, as you have indicated, sir, and I think it would be better if we spoke in generalities rather than of Algonquin Park in particular, because that is strictly a provincial issue.

Senator Cameron: I am afraid too many people are speaking in generalities, in the papers, and so on.

Dr. Prebble: That is true. In one park in the early forties a very serious outbreak occurred of what was known as mountain pine beetle. Our staff were heavily involved in a program to remove those infested trees, with alternative service personnel involved in the actual cutting and removing.

This is a good illustration of what can happen in a so-called wilderness area, if forest renewal is not provided for in one way or another. In this case the pine beetle was taking the place of man, removing trees that were susceptible to attack.

I think you will find many foresters in general with a strong conviction that you cannot preserve a forest forever, allow it to become decadent and so on. Sooner or later you have disease outbreaks, insect outbreaks, fire, and so on. The foresters take the view that conscious careful deliberate management is the best way of preserving what you might call the natural heritage. Among foresters in general there is not too much support for the concept that very large areas can be kept in good condition by conservation in its strictest sense, which means, conserved against use.

Foresters, on the other hand, are strong supporters of the concept of conservation in the sense of preservation through use, and I think that would be our answer to your question, sir.

Senator Cameron: In other words, there is a scientific justification for controlled logging, even in the park? I am not trying to sell this: I am trying to get at the facts.

Dr. Prebble: Yes, that is our belief, sir. This question has been discussed time and time again and even on the reserves and national parks we know it is the policy of the parks branch to preserve the parks against what you might call exploitation or use as a conservation measure. But trees grow old and they do not remain equally viable and resistant to pests and diseases forever. Sooner or later, unless they are removed, they are going to fall a prey to insects and diseases or fire, and at that stage you have a worse situation than intelligent periodic use of the reserves.

Senator Cameron: I would like to take some of those wilderness experts, armchair scientists, and such, into a tamarac swamp 80 or 90 miles west of Edmonton and see how they could move through it. They just would sink in moss up to their hips. It is also a fire trap. Even the foresters cannot go into it. Even the wilderness lovers cannot get in there.

The Chairman: Senator Cameron, I know that Senator MacKenzie has some questions and he also must leave very shortly. Could we turn to him now and at a later stage come back to you?

Senator Cameron: Yes, Mr. Chairman.

Senator MacKenzie: Honourable senators, I should first like to apologize for the fact that I have not been with this very interesting and important committee for some three weeks. As most of you know, I have been on other duties in other parts of the world.

I have had the rater unique experience and opportunity of serving with three of the four faculties of forestry, schools of forestry in Canada. I taught students in the faculty of forestry at the University of Toronto—not in forestry, I hasten to assure you, but in my own field of business methods and commercial law. As President of the University of

New Brunswick and later of the University of British Columbia, two other universities with faculties of forestry, I had a direct administrative concern for the work in those institutions and for the work generally across Canada. By temperament and my own way of life I had a rather special interest in the forests and forest industries and their development and incidentally with fisheries too.

Now, just a few generalities; Senator Cameron has raised a number of questions that had occurred to me about forestry in Canada. I start with the assumption which I believe is reasonably accurate that the governments of Canada obtain a great deal of income from our forests in a variety of ways. Our whole economy gains a great deal from the forest industries and the forests of Canada and quite frankly on the basis of my own knowledge and experience I have been almost shocked and certainly bitterly disappointed at the failure of governments, and for that matter, industry, to recognize the importance of our forests other than to get income from them, and of those engaged in forestry, professional forestry, our research forestry and academic forestry in the country. The idea that the federal Government is providing $40,000 a year to each of the four universities in Canada should be looked at in terms of what the Government has been providing and is providing, let us say, in physics. We had here not long ago the representatives of the Atomic Energy Board and the Research Council who talked to us about a project that was contemplated and running into millions of dollars—not thousands of dollars, but the millions, and to me this just does not make sense. We ought to be spending a great deal more money than we are now spending in these areas of our forest industry. I would like to underline that and emphasize it.

Now another fact has impressed me has been the lack of opportunity in Canada for young men and women who are educated in the faculties of forestry or who could be educated in that faculty or who would like to be educated in them, and this relates back to the lack of opportunities in the terms of lack of financial support. In the main our faculties of forestry have not been as important, and, for that matter, have not had as many students as some of these other departments and faculties that we are all familiar with and know about. It seems to be part of our history and our tradition.

Now in terms of the matters that have interested me, the first, of course, is the maintenance of our forest resources and this is partly protection and mainly reforestation. We have not yet done nearly enough in respect of the protection of our forests. Some mention was made a moment ago of selective logging with a view to protecting the forests from disease and from fire. These are two of the main enemies, naturally, of the forests. The experts will know which is the greater danger and which has caused the most damage over the years. You will be able to say whether it is fire or disease or both. But clear-cutting, unless measures are taken to ensure the replanting and the reforestation, is also a very serious matter both in terms of failure to recreate this very important natural industry or to leave it as a waste land when it could be utilized more effectively—waste land in the sense of the second growth that comes along after there has been clear-cutting.

Now, just one or two questions, and perhaps the answers could be supplied by those who are appearing here in a memo which would save their time and our time. I am interested in the measures taken to deal with, for instance, the spruce budworm which, years ago when I was familiar with this, was under the control of Barney Flieger of the University of New Brunswick, and later Montreal, and which was a very interesting experiment. I would like to hear a little more about the results of that very important experiment over the years. I would like to know what side effects it has had upon the fish industry particularly the salmon, trout and sport fishing in the area, and whether or not the use of insecticides is the kind of menace that we are learning it to be in other fields of activity and in other ways.

I remember too that my good friend Reg Balch was developing in a sense parasite control of these enemies of the forests and I would be interested in learning the extent to which this is being done and how successful it has been. Then there is the question of selection of seeds. I know some work is being done there.

The Chairman: Could we deal with this first question first?

Senator MacKenzie: I would prefer if it would be in order for me just to raise these questions and leave them with you and per-

haps we could have a memo on them or they could be answered in due course. I don't want to take too much time. I have one or two others to put on the record—the selection of seeds and the use of fertilizer from aircraft in promoting the rapid growth and the certain reproduction of young trees from the seeds.

Coming to the second stage of the industry, again something that has impressed me as I have wandered through the forests of this country has been the waste, and I have often wondered and I have often hoped that in time we would be able to do more of what I know the European countries have done and are doing in respect of this tremendous wastage of trees. We have understandably taken the logs and the pulpwood and left everything else. Now we are beginning to use better methods in mills in respect of the utilization of what were formerly waste products, but I think this is again an area in which much more can be done in research and experimentation and the use of technology and science.

The only other thing that I wanted to raise—and this is, I suppose, inevitable because of the nature of our democracy—is that sometimes the best uses are not made of the resources at our disposal. I have in mind the question of the location of certain federal Government facilities interested in this area. It was decided—I believe for political reasons—that one group of them should be at Vancouver and the other in Victoria. I believe this was contrary to the advice of some of the experts in the field.

Again, this is something that those of us who are Members of Parliament, in the sense of having some political responsibilities, could assist in. I had in mind that the location of these facilities adjacent to each other or in the same general area would have enabled the people working in them to work together more effectively and to use the same kind of resources.

I could go on, Mr. Chairman, but I do not want the answers to these questions immediately. I am very grateful to those who have given way to me so that I could get in my few suggestions and ideas. Thank you.

The Chairman: Senator Bourget?

Senator Bourget: Mr. Chairman, I would like to follow one of the questions that was asked by Senator Cameron. This has to do with the four Canadian forestry schools that we have. Where are those four forestry schools?

Dr. Prebble: The University of New Brunswick, Laval University, Toronto, and the University of British Columbia.

Senator Bourget: I quite agree with my colleagues that a grant of $40,000 a year is very little. But is your department the only one that gives grants to those schools?

The Chairman: I think that this figure is a kind of general grant, but I think you have to go back to page 43, where you will see that for the current year the department is giving support of R and D in universities to the extent of about $200,000, in addition to this $40,000, and then there is this other amount of $160,000. So, the $40,000 is not the only program.

Senator Bourget: The question I would have liked to ask, Mr. Chairman, is this: Is the Department of Forestry the only one that gives grants? Or, for instance, is the National Research Council giving grants also to those universities?

Dr. Prebble: Yes, sir.

The Chairman: In the field of forestry?

Dr. Prebble: Yes, in the field of forestry. I think the extent of the program from NRC varies from year to year and from school to school, but each of the four does have programs supported by the NRC.

The Chairman: You would not know the amount? I think we have it somewhere.

Dr. Prebble: I cannot tell you offhand, but we have a record of that in the reports that have come to us from the Deans when we were discussing programs.

The Chairman: Would there be anything from Agriculture?

Dr. Prebble: I do not think there would be anything from Agriculture in forestry support, but there are programs supported at universities by Agriculture.

Senator MacKenzie: But the fact is the total support of forestry in universities or anywhere else, in relation to the importance of the industry, is insignificant.

The Chairman: We are trying to come to that senator, gradually.

Senator Robichaud: In order to clarify the figures quoted on page iii of the Summary and Main Conclusions, which shows that $1\frac{1}{2}$

million have been distributed in grants, could we have details of those grants? If only $40,000 or $200,000 are going to universities, where are the other grants applicable?

Dr. Prebble: Mr. Chairman, senator, to be precise, that should be called "Grants and Contributions." The largest part of that figure, approximately $1 million is in support of the forest survey and land capability program in the Province of Newfoundland and Labrador. That is a program that has been going on for about three years as a special program to make them aware of the land and the forest resources in the Province of Newfoundland and Labrador. That is a very large element of that item.

Senator Bourget: On page 32, Mr. Chairman, we read:

> The regions are not all faced with the same problems, and activities in certain fields are more properly carried out by the Branch in some regions than in others.

Does it mean the different branches are free to develop their own research program? Have you a kind of co-ordinating committee that would tell those branches to do some kind of project? I ask that because that is what some of the members, indeed all of the members are worried about. Is there duplication of work and research done by the different branches?—after reading this particularly.

Dr. Prebble: As I said earlier, the overall programs in the regional establishments are under the guidance of the advisory committees. On the other hand, there is a kind of gradual flow of problems from east to west across Canada, and no establishment is completely different from its neighbour on either side. We try to avoid duplication of programs as between, say, the Maritimes and Quebec, or Quebec and Ontario, by having a good deal of inter-regional collaboration among our own people—in other words, setting up task forces. The program is co-ordinated at headquarters by a group that arranges for collaboration and tries to avoid overlap between the different establishments. So, by and large, the programs within the regional establishments are geared to the needs of the region, but in cases where the same problem might occur in two adjacent regions we may work in a collaborative arrangement so that one establishment supports the other.

Senator Bourget: I read somewhere in your brief that you have a national advisory committee which is composed of men who come from the industry. There are no members who come from the universities or the forestry schools. I read also that this national advisory committee is the one that reports to the deputy minister.

Dr. Prebble: Yes, at the present time, that is correct, sir. Our advisory committees in forest research programs are regional committees. The only national committee we have is one on forest products. I might say that attention is being given at the present time to the broadening of the function of the advisory committee at the national level so far as forestry and forestry programs are concerned.

Senator Bourget: How do you establish priorities in your research program?

Dr. Prebble: I think one has to speak in generalities here. First of all, the program must have a relevance to either the regional establishment or research institute from which the proposal is made. It must have a relevance nationally as well, of course, because our programs, no matter where they are carried out, are supposed to have a relevance beyond the immediate time and place.

There must be an agreement about the problem that is under consideration. First of all, it must be decided whether it is susceptible to research effort within a reasonable period of time, and that the out-puts will far outweigh the in-puts in terms of time and money and people. We try to assess them from the point of view of ratio of return to cost.

I must admit that we are still groping a little bit on the concept. We are trying to put into quantitative terms ratios of potential output in relation to costs. In other words, the cost part is much easier to evaluate and quantify than the potential benefits. We are moving slowly in that direction, and we are trying to get the advice of economists to the fullest extent possible.

The final decisions on priorities are made intra-regionally by these committees I spoke of earlier—the advisory committees—and on a national basis by our directorate of program co-ordination, which is meeting next week, in which we bring all our establishments together, sometimes twice and sometimes three times a year, when the problem areas that are under discussion are reviewed as objectively as possible, and a decision made with

respect to in-puts and commitments on our behalf in relation to what can be seen as potential benefits from the programs.

Senator Bourget: Does the lack of money prevent you from undertaking important projects in research that you would consider as having priority?

Dr. Prebble: At the present time we are facing some real problems, especially in 1969 and '70, in the sense that we are in what you might call a static situation with respect to staff and money. We are having to look at some high priority problems which will force others to a much slower pace, and probably some of them will have to be closed out. I think the answer to your question is that the highest priority items can be handled with our present staff and funds, but we are not able to take under our programs all the things that everybody outside our own organization, the provinces, and the industry, want done. So, we are forced into a broad and rigorous assessment of priorities, having regard to our funds and budgetary situation.

The Chairman: But in the normal process you rely on your individual researchers to propose projects, and then these proposals go through the usual procedure, and eventually come to your central committee for review?

Dr. Prebble: Mr. Chairman, there are several avenues by which proposals reach us. It is true that many of the suggestions come from our research staff, but by no means all. We receive a great many proposals from the industry, and from provincial departments.

The forest products industry has gone further in attempting in their own estimates to put some quantification on the proposed benefits to come from their proposals, and they are reviewed by these advisory committees in the various products fields. In the broad national field the national committee makes suggestions on broad areas of research in the various fields. We also have suggestions coming from the universities.

So, there is a varied inflow of suggestions, and they are monitored by the national advisory committee, the various products advisory committees...

The Chairman: But, would you say that 75 per cent or 80 per cent originates from your own research staff?

Dr. Prebble: I think it is safe to say, if you think of problem areas rather than individual projects, that in the problem area concept we would get more than half of the proposals—probably three-quarters of the proposals—coming from the provinces and the industry on whose behalf we work. But, when it comes down to individual projects—such as how to make a contribution to the problem area—then most of those proposals come from our own staff because they are staff specialists in the field.

Senator Cameron: What contribution does the industry make to the research programs. They may make direct grants to universities for special projects, but they do not make any directly to you—or, do they?

Dr. Prebble: They do not make financial contributions to individual projects but their collaboration is essential for much of the work we do in the forest research field, because we use their facilities and we have collaborative effort in the field programs, and in accommodation, transportation, and whatnot. In the forest products field we have extensive collaboration with the industry. Some of our projects are carried out in industrial plants. There is even collaboration in respect of staff in outlining proposals, and joint effort in carrying out projects in the forest products field.

Senator Bourget: But there is very little money spent in extra-mural programs. I think it is about...

Dr. Prebble: It is about $200,000 for extramural research grants at the present time.

The Chairman: In relation to this it seems to me also—and you mention this in your presentation—that development takes a very small share of your total research budget. I do not know if this is the proper figure, but at page 43, where you mention engineering and technology under the heading of "Scientific Disciplines", there is the amount of, let us say, $1.5 million. Would this cover the development work which is done by the department?

Dr. Prebble: No, sir. I think that this is due to the requested breakdown. It is a very cumbersome breakdown for us to follow, and I might say that much of our difficulty in preparing this brief was in attempting to subscribe to the format. This item represents that part of the forest products investigational field which is covered by engineering and

technology, but not all the work in the forest products field would fall into that category because we have quite a lot of work on chemistry, bio-chemistry, by-products, and things of that kind. This would be that part of our forest products field which can be characterized as engineering and technology.

The Chairman: How would you estimate the amount of development work which is done in the two forest products laboratories in Vancouver and Ottawa?

Dr. Prebble: Quite a substantial amount. We have a reference to this on pages 68 to 72, in the field of what we call application of research findings. At the present, that admittedly represents a very small part of our budget about 8 per cent. It is rising gradually year by year, but that covers the work in the forest product field, and also in forestry, silviculture, protection and so on. Admittedly it has been until quite recently a very badly underdeveloped part of our program and for the last two or three years we have been putting a greater effort into that annually, and have also been employing people whose chief function is the application of research findings.

Senator Bourget: On page 43 I see that the support of research and development in industry is going down very rapidly. What is the reason for that? Is industry not interested?

Dr. Prebble: This is another part of a table which is very difficult for serious application. At the bottom of the page you will find a reference to industry with a footnote. That is the federal Government contribution to the pulp and paper research institute at Pointe-Claire near Montreal. That is a capital contribution towards the development of new facilities there.

The Chairman: So this is the only support you are giving to industry?

Dr. Prebble: Direct financial support, yes.

Senator Cameron: And none projected for 1968-69?

Dr. Prebble: Yes, that has been completed.

Senator Bourget: How close is your relationship with the pulp and paper industry?

Dr. Prebble: I would say quite close. We have two representatives on the board of directors of the Pulp and Paper Research Institute; we have a man with the Technical Advisory Committee of the PPRI; we have another man on the Woodlands Advisory Committee. As far as the Pulp and Paper Research Institute is concerned, we are covered at three levels—the board of directors and two advisory committees. Generally speaking, on a broader scale, if we are talking about our collaboration with industry, it is found through the regional advisory committees to which I referred and forest products advisory committees. We also have membership in the Canadian Pulp and Paper Association.

Senator Bourget: What about their research? Is it very different from the research you are doing in your laboratories? Are they mostly concerned about machinery to harvest wood, the logging business?

Dr. Prebble: The research being carried on by industry can be spoken of in two channels, I think. First of all, there is that effected through the support of the Pulp and Paper Research Institute, and a great part of their effort is in the pulp and paper field. They do have a woodlands research program and we are collaborating with them in certain aspects of that program. Apart from the Canadian Pulp and Paper Research Institute, a number of larger companies have research departments. There again, the same emphasis is in the products field. In the east, and also in British Columbia, they have woodlands research programs, again with collaboration from our own branch.

Senator Bourget: In recruiting your research personnel, are you encountering many difficulties in finding good research people, and also keeping them?

Dr. Prebble: Our staff turnover in research personnel is something in the vicinity of 3 per cent per annum. We lose two kinds of people. We lose very young people, who find the career is not exactly what they had in mind—and sometimes we encourage them in that belief after a year or two with us! We also periodically lose senior people who are recruited into senior university posts. In the latter case, it quite often is beneficial because we have in the universities people who are interested in our line of work and over the years the turnback may be five or ten to one. Some of our most recent recruiting

has been traceable to people having joined university departments after being in our department for many years.

Senator Bourget: On page 40 I read that there has been a considerable number of resignations. What is the reason for that? Is it salary or other reasons?

Dr. Prebble: I would say there are several reasons that lead to resignations. It may be that by chance there is a policy decision to relocate major establishments in one area, and very often staff do not find it possible to adapt themselves to being located in the new area. We have had a number of resignations on that account. We have had resignations because of opportunities opened up in universities, from time to time in provincial departments, very occasionally industry.

Senator Bourget: Are those leaving you staying mainly here in Canada, either in universities or in industry?

Dr. Prebble: I would say the preponderance of people who have left us in recent years has remained in Canada, either with provincial services or with universities, occasionally with industry. We have lost a number of people to senior posts in American universities.

The Chairman: Why not industry? You say it is only occasionally industry.

Dr. Prebble: Only occasionally industry, that is right, sir.

The Chairman: Is that because they do not have the background or the interest to go to university, or because there is no market for them?

Dr. Needler: I think this is to some degree evidence of the fact that the actual research carried out by industry and the actual research carried out by the forestry branch do not overlap, so that industry is not carrying out much research in fields which interest those in the branch.

The Chairman: So you would say that you concentrate in fundamental and applied research, but industry would be more interested in development work? Would that be fair?

Dr. Needler: I think there is even a subject difference too, because the branch does not carry out some research of a more or less fundamental nature in the pulp and paper field which the Pulp and Paper Research Institute does, for example, so there is a subject separation to some degree. I think it is because there is to some degree a lack of overlap.

Senator Bourget: On page 56 I read:

> Only a few results or processes arising from forestry research are patented.

What is the reason for this? Is industry not interested, or has it not been developed to the extent that industry could take over from the point you have left off?

Dr. Prebble: That is a subject that is under constant review. Most of the applications for patents come from our forest products laboratories and we work very closely with the Canadian Patent and Development Corporation in that; they make searches. Very often an idea which is thought to be patentable is determined not to be patentable. Consequently, after a year or two it is reported to us that by and large it is a good idea but it is not patentable, although a great many of these things are used in industry but are not patentable because of close relationship to something else that has already been patented. In the biological field and the forestry field generally you seldom come up with patentable ideas. The ideas may be very useful, but they cannot lead to the development of a patent.

Senator Bourget: Just for the sake of information, that process for pulping lignocellulosic materials, has that process been developed by Anglo Canadian Pulp and used as a road binder?

Dr. Prebble: I have not got the details of this patent in front of me, but I think this is purely a process which you might call a digesting process for getting the cellulose fibre from wood.

Senator Bourget: I know Anglo Canadian Pulp has developed that kind of material which is used largely on roads now.

The Chairman: Could we go to Senator Lang please.

Senator Lang: Senator Cameron asked my question.

Senator Cameron: May I come back to this, which relates to the current controversy. It intrigues me very much and it reflects on policy. It has been stated in connection with

Algonquin Park that 25,000 people will be put out of work if not permitted to log there, the reason being that the only source of hardwoods in Ontario is in the park. This is incredible to me since Ontario orginally has been a great source of hardwood. What has been done to re-plant and re-establish the hardwood areas in Ontario? Supposing if this statement is true and it may not be—it is a newspaper statement—and 25,000 people are put out of work, once that source of supply of hardwood for furniture-making is used up there is no other source. This does not seem credible at all. What is being done or what has been done to replace the hardwoods in a way of an organized program?

Dr. Prebble: Ontario has a provincial research organization with which our research establishment in Ontario works very closely. Both the research establishments have been concerned with the regeneration of hardwood stands and have a special research group set up for that very purpose. Ontario, as a province, has done a great deal of what we would call development work in re-establishing hardwoods, especially yellow birch, a very valuable hardwood—special attention at the time of cutting to establish regeneration, scarification to make it possible for seedings to become established in mineral soil.

There are quite extensive hardwood stands in other parts of Ontario, especially north of Lake Huron which I think possibly are not quite so valuable as those in the park area and then of course there are stands in Southern Ontario. South of the park many of the better hardwood stands were cleared for establishing agriculture in those areas. There was black walnut and other very valuable species and our own research program has been developing, in collaboration with the province, an attempt to make it possible to reestablish some of the more valuable hardwood stands in areas that do not have a good growth of any kind.

I might say that in the Province of Ontario many years ago there was an attempt to establish more of the more valuable hardwoods in Southern Ontario, but there had been inadequate research before the programs were initiated and that is the reason the research programs are being more extensively developed at the present time. It has been much more difficult to establish hardwood plantations than those of coniferous trees. The demands of species are much greater and not enough is known of the silvical requirements of the species.

Senator Cameron: Does this suggest that the Ontario woodlot program in which they are encouraging people to cultivate woodlots, as a cash group, has not become an economic factor at all? Is it just experimental?

Dr. Prebble: I think there is quite an extensive program to encourage woodlot development. I think it may be rather dangerous to put some of these programs in the light of some of the recent controversy you have been referring to. I do not think the qualification should be accepted 100 per cent as stated, although I think it is quite clear that many of the communities have been dependent on the wood resources of Algonquin Park.

Senator Cameron: Is it possible for Canada to reestablish the hardwood forests on an economic scale for research and development? Can we do it? Are the resource sources gone forever?

Dr. Prebble: I think the resource has not gone forever. You can still fly over hundreds of miles of hardwood forests in Ontario and Quebec as well as parts of the Maritime provinces. There have been some very deleterious disease outbreaks in the hardwood stands, especially yellow birch; the famous birch dieback some years ago caused heavy losses. Beech was seriously affected in the Maritime provinces during the thirties and forties, but there is nothing in the whole complex of hardwood forests that would make it impossible to continue to have good stands and to reestablish new stands in areas that have been devastated. The furniture industry is pushing very hard for just that to be done.

Senator Cameron: How strict are regulations being enforced when forestry operations are being carried out to see that adequate steps for replacement are followed, re-forestation in forested areas. Is this being carried out?

Dr. Prebble: I think, sir, I can speak more particularly for Ontario than I can for other provinces, but I would say they have been very conscious of the necessity of maintaining their hardwood resource in good condition in Ontario in recent years and much of the research and development programs have been done to that end.

Senator Cameron: What about British Columbia?

Dr. Prebble: I think the hardwood resources of British Columbia are almost non-consequential.

Senator Cameron: I am not thinking so much of hardwood there, but the forest resources.

Dr. Prebble: I think British Columbia has had a very active re-forestation program going on for many years. They are one of the leaders in Canada in that regard and the program is being stepped up year by year. We have been collaborating very closely with them in new approaches to regeneration in British Columbia, using other than traditional techniques of planting the bare root stock and it has been a collaborative program of the province, the industry, the university and our own establishment, as well as the British Columbia Research Council. I would say that British Columbia is very conscious of the need to maintain its forest estate.

Senator Cameron: Something bothered me a bit and this is the constant reorganization of departments and transfer from one department to another. I understand there is one government department, which I shall not name, that has been transferred seven times in eight years. Now, you are in the process of being transferred, but there is so much of this going on it seems to me that there must be a tremendous loss of labour in getting reestablished. This may not be a fair question to ask a civil servant.

Dr. Needler: Mr. Chairman, I do not think it is. I do not think you can expect public servants to speak their minds on this question.

Dr. Prebble: I think the people who are furtunate enough to be located in research laboratories hardly are conscious of this, but I will say it bears very heavily on a few people, especially a person unfortunate enough to be an Assistant Deputy Minister.

Senator Cameron: I think so much of this is going on that if this happened in private industry there would be a certain amount of chaos. I think that one of the things we have to say is "is so much of this necessary?". I think you are right that it does not affect people who are in research establishments so much. They carry on with a new name or a new branch. But this constant shuffling of the departments should be looked at. This is not your responsibility. These are political secrets.

The Chairman: And those are your own comments?

Senator Cameron: That is right.

Senator Kinnear: Mr. Chairman, I think we have covered the waterfront very well with questions and long preambles, and many of my ideas were taken up; but I think I can find a few here and I shall endeavour to do so.

When Senator Cameron was talking about the hardwoods, one of the loves of my life is the lovely walnut we have in Ontario. I am glad to hear you say the furniture people are pressing hard to preserve our walnut, now we are running into the loss of all our elms in Ontario, and it is costing a fortune to have them removed.

I would like to ask about the maples, because the maples I understand are subject to a great deal of disease.

On page 12, what about the continual spraying. Also, on page 18—I think they are very much alive—those two pages.

Senator MacKenzie spoke of the budworm on spruce, and so on. What effect does this very heavy spraying have on the forests and the run-off into the rivers? What effect would you say it has on fish life and on any other forms of life?

I would like to go on to develop that, but do you want to answer on that and then I will develop the DDT question perhaps a little further; or would you like me to put my question on DDT, too?

Dr. Prebble: Very well.

Senator Kinnear: I would like to quote from the New York *Sunday Times* of December 1, which says:

> DDT is the cheapest and most widely used of the so-called persistent pesticides because it does not readily break down in its constituent elements.

That is as far as I want to go there. Later on in the article it goes on to say that it lives in animal life and is found around the world, even in Antarctica.

I would like to know whether it is harmful to humans. They do not seem to go that far in

their research. Certainly we take DDT into our systems. Have you done any research on that?

Dr. Needler: I think that is really a subject for another department, the Department of National Health and Welfare. I would like to say this, however, that there is no question of the hazard of the spraying of insecticides to fish. It is something that the other branch of our department has some experience with, but lately there has been a very close co-operation between various departments concerned with pesticides, throughout an interdepartmental committee. There have been adjustments made in quantities used per acre and in the methods of application and the details of areas of application, and I think that has minimized this damage.

In my own personal opinion, however, the whole use of pesticides is one of the most hazardous of all human activities. I would put it up with the same importance and it may be of higher importance, than the atomic bomb because it is a little bit insidious. These things come into use without adequate knowledge of their side effects.

There has been a rather encouraging development lately, in thinking which is evident in federal Government circles, I notice, and elsewhere. It is that we are working towards the use of pesticides which do not persist, so that we are reducing the danger of accumulation of pesticides and eventual damaging of the human environment.

This undoubtedly is one of the most important subjects in human biology as well as in man's use of biological resources.

The Chairman: In relation to that, is there any research being done on the use of parasites in substitute for insecticides?

Dr. Prebble: Canada has been active in biological control for over 50 years. As a matter of fact, one of the first forestry projects, undertaken in 1912, was in the field of biological control. I think Canada can claim the most outstanding success, in so far as protection of the forests is concerned by the use of parasites and pathogenic microorganisms. We have a very active program on that in the department and collaborate with the Department of Agriculture and an international institute known as the Commonwealth Institute of Biological Control.

Unfortunately, the method is not equally successful against all and sundry pests. The method is most likely to be successful against those pests in Canada which are an importation from abroad. It is much more difficult to attain successes with the native pests which periodically become abundant, because over aeons of time that insect or pest has become adapted to its own biological agents and occasionally breaks away from them and causes trouble. We have been successful in adapting certain pathogenic microorganisms and I think there is much greater likelihood that they will be technically brought into more use in the future than the past.

Development of biological control has been successful in plantations, man-made plantations, that sometimes encourage pest problems, and these have been more amenable to control biologically than the large native stands of trees. When you have a native pest occurring over thousands or hundreds of thousands of square miles of Canadian territory, virgin territory, you might say, the chances of effecting biological control quickly or in the near future are much less than in the control of pests whose distribution is limited and which have not become fully attuned to the Canadian environment. We have a constant program going on in this, also touching on the spruce budworm. I am sorry that Senator MacKenzie has left, because he touched on a number of points of interest to me historically and which I could have answered in another five minutes.

At the moment we do not see much likelihood of an attack on spruce budworm by the classical biological control methods, but at the same time progress is going on with insect pathogens, parasites and predators.

Senator Kinnear: I wonder if you would comment on the loss of the elms. Is there any control of that yet?

Dr. Prebble: The Dutch elm disease is a situation which represents a rather dynamic challenge. It has been in North America for something more than 30 or 35 years, and it has been in Canada for 24 years. It was discovered here first in the area near Sorel, Quebec, and more recently in Ontario. It is not fully coexistent with the existence of elms, but it is gradually becoming so. We have a native pest or beetle which transports the fungus disease from one tree to another

and in some parts of Canada there has been introduced a beetle from Europe which does the same thing. A great deal of work has been done on the control of what we might call prize specimen trees on properties and lawns and so on, and DDT is a very effective residual insecticide that will protect elm trees from Dutch elm disease. However, even though it is a good residual insecticide it has come into disrepute and there have been instances of damage to robin population and this has caused resentment against the use of DDT for Dutch elm disease control. But a chemical control program by itself is not enough because in many situations the elms are quite old and have dead branches and you get infections of the trees through beetle population increase in the dead branches, and if the fungus happens to be in the area you get a very rapid build-up. On the other hand if you have a carefully designed sanitation program of removing the dead trees and the dead branches, combined with a chemical control program,—in those circumstances the disease can be kept under control. The best illustration I can think of at the moment is in Fredericton, New Brunswick, which is a city of old elm trees. They have had a program of sanitation and the average losses have been amounting to one per cent of the population, which is a tolerable amount. You can maintain a good stand of shade trees at that rate of annual loss. However, in other parts of New Brunswick and in other parts of Canada where the program, the sanitation program, is either nonexistent or is carelessly done, you have losses running to five or ten times that population loss per annum and this of course we cannot stand. It has to be recognized as a community effort. It is something of course that cannot be really efficient on a woodland basis because of elms being scattered throughout these mixed woods. But in municipalities and similar situations such a program can be done.

Senator Kinnear: It is a sad situation in Ontario to drive through the countryside and see the numbers of dead elms.

Senator Belisle: May I ask a supplementary question? Is there a serious check at border points regarding the importation of shrubs and trees, and what is the purpose of it? Can it affect new diseases coming in from the United States?

Dr. Prebble: Where material comes in through commerce, our experience of the importation of materials from abroad, from the United States and from Europe, is that our inspection points have a good chance of detecting and preventing the entry of foreign pests. On the other hand, on the international border there is no barrier against flying insects or wind-borne spores and many of our problems in Canada and the Atlantic region, and especially in the region along the borders of Quebec and Ontario, many of our pest problems come in from the United States. Inspection points at ports of entry are of no benefit in that regard. However, if infestations can be caught when they are still small enough you still have some opportunity of restraining their spread, and there has been a lot of effort put into that. The inspection service maintained by the Department of Agriculture under the Destructive Insects and Pests Act collaborates closely with other people on inspection and periodic examination of problems, and we have been consulted on the periodic revisions of the regulations under the act.

Senator Kinnear: You mention here instances where you are able to use wood from the dying trees. On page 103 you say "Other studies have made possible more effective utilization through the definition of priority cutting schedules in mature and over-mature timber. Research on decay and deterioration of forest stands injured or killed by insects, fire, wind, or some other cause has provided information that has made it possible to economically salvage such wood for industrial use." That is very interesting. How much work is being done on that?

Dr. Prebble: There has been a very extensive program over the past years on the rate of deterioration of timber killed by fire and also the rate of deterioration of trees killed by pathogenic diseases or by insects. It depends a great deal on the products that come from that material and how long the material is salvable. In the case of material to be used for pulp and in the case of balsam fir which is one of our more rapidly deteriorating species, you usually would have no more than two or three years of salvage opportunity. Then you have sufficient loss through sap rots and breakage that salvage after that time is not worth while. In the case of high value saw logs you can have a very heavy borer attack—the entry of large wood borers—so that in one season you can get a penetration of two to three inches and that will highly

de-grade the lumber coming from that material. In the case of extensive killing of saw logs or saw log materials salvage has to be done within a year or less because otherwise there will be heavy de-grading in the value of the material that comes from these trees. Uusually in the case of a large outbreak of fire the amount of material that can be salvaged is limited and is in fact a very small proportion of the total loss. By and large salvage has not been able to keep pace with the larger outbreaks of fire, insects and diseases.

Senator Lang: Mr. Chairman, I have an impression which may not be correct that good forest management practices enforced upon logging companies and pulp and paper companies through control by licensing, etc. are very lax in Canada as compared with those enforced upon counterpart organizations in the United States. I would ask one of the witnesses if they might comment on that as to whether it is true and if it is true to what extent it is valid.

The Chairman: They may not want to answer it, because they are not responsible.

Senator Lang: It is a provincial jurisdiction, but it must certainly come under this branch.

Dr. Prebble: I am not at all sure. You must keep in mind one thing, of course, the situation in Canada is not completely the same as in the United States. There is a very large proportion of the forest resources of the United States under the control of the federal government, either through the United States Forest Service under the Department of Agriculture, or through the Department of the Interior and, therefore, there is in the United States what you might call an opportunity for unifying systems for a much larger part of the country than in Canada. In Canada, the provinces regulate the administration and the management of the forests.

There is a possibility for a greater variation in Canada than in the United States. There is a much higher proportion of private forest land ownership in the United States than in Canada where the companies own the land freehold. They have a much stronger incentive for heavy investment in the forest estate, because they own the land and it is going to be in their possession for an indefinite period of time in the future.

Notwithstanding those comments I do not know if I could support your impression. I do not know enough about the points of contrast to be able to say that the situation in Canada is very lax compared to that of the United States. I do not know that it is correct, however I am not denying it.

Senator Lang: May I come to beech. This is an area that I know nothing about. For instance, in the Province of Ontario are logging companies and pulp and paper companies required to re-plant after they cut, and if so, to what extent?

Dr. Prebble: Legislation in Ontario places responsibility for management on the provincial department. By arrangement with the companies they can very often delegate that responsibility back to the companies under careful check and balance.

The Chairman: Is there any obligation to plant after they cut under the present system?

Dr. Prebble: If the responsibility is not delegated back to the company the responsibility rests with the provincial Department of Lands and Forests, but in many cases they have found it advantageous to delegate that responsibility back to the operating company under, as I say, check and balance. They actually check and see that the work is done according to provincial specifications.

Senator Cameron: Do you not think it would be wise to make it part of the program to enforce that a company getting a timber logging licence should be required to leave the land reforested and in a condition to which it would renew itself?

Dr. Prebble: I think that goes back to a policy decision reached in the province some years ago and it goes back to this question of security of tenure. I believe there was quite an active dialogue between the operating companies and the provincial government and it was concluded that since the province was the agency that was determining the tenure duration of the licences the ultimate responsibility rested with the province to see that the land was kept in a state of renewal. As a consequence of that, the major responsibility was vested in the provincial department so that the land was kept in a state of renewal, but in the operating arrangements it was often found advantageous to work out a deal,

a re-delegation of that responsibility back to the company, that would carry with it an exchange of funds between the provincial government and the industry to carry out the things the province said should be done.

Senator Cameron: I suppose the province charges a percentage for letting them timber and this should be high enough to cover the cost of replacing.

The Chairman: Before we go on with other questions, I do not think that since we have only about a maximum of an hour with our guests this morning that we should spend too much time investigating provincial policies on forest management.

Senator Belisle: I should not add what I am going to say.

The Chairman: Say it.

Senator Belisle: I disagree with my honourable colleague, Senator Lang. For many years I was a member of the provincial government and I received many delegations from management and they felt the relations imposed on them were putting them out of business and I will say that Ontario has much more rigid regulations and are adhering to them much more than any other province that I know of.

The Chairman: We will register your comment.

Senator Robichaud: Mr. Chairman, the question I had in mind to ask has already been touched by Senator MacKenzie and Senator Kinnear. It has to do with the spraying of forest such as certain areas which were sprayed because of the spruce budworm. I know in the past there have been reports to the effect that the spraying had really affected fish life or the fish population in streams or rivers adjacent to spraying areas. My understanding is that following such complaints the concentration of D.D.T. has been reduced in the spraying. My specific question is what effect has this spraying had in preventing or controlling the spread of budworms in affected areas?

Dr. Prebble: I see Senator MacKenzie back in the room again.

The Chairman: He did not want you to answer his question.

Dr. Prebble: I know he did not.

Senator MacKenzie: I wanted it answered but not today.

Dr. Prebble: First of all I should say that D.D.T. is practically out of the picture as far as the program in New Brunswick is concerned. It is used to a very limited extent now in areas where non-hazardous spray is used even though fish population is in the rivers. In other words the program has swung over almost completely to non-hazardous insecticides, organophosphates, and that of course has been a compromise arrangement arrived at between the federal and provincial forestry, fisheries and wildlife people. I think it has worked quite well and every person has given a little bit on his side so that the whole program can continue. In other words, it has been a compromise situation wherein no one interest is asked to suffer the whole, without some expense to others.

I think I should say something on the question of spread. I would like to say that the programs in New Brunswick were never designed to prevent spread. This is a native pest we are dealing with and it occurs throughout the spruce-fir forest everywhere they occur in North America. The whole program was geared to maintaining trees in a living condition so that the resource would not be devastated over a period of four or five years. The progoram has been very successful in maintaining trees in a living condition without serious losses. The losses have not been consequential as far as the timber resources are concerned, but the program was not designed to prevent spreading of the infestation which occurs throughout the forests.

It is a program very consciously designed to be applied at a time when the forest in any particular area was in hazardous condition and needed preventive treatment for a one-year or two-year period or whatever time was required. From that point of view it has been quite successful. Northern New Brunswick has been brought through a series of outbreaks over a period of six or seven years with very minor losses. We know the consequences which would have resulted if the program had not been carried out, because two large check areas were preserved from spraying right from the start of the tests, demonstrating what would have happened. The check areas of about thirty

square miles each were devastated. In central New Brunswick there is a program which is quite active, and will be continued in 1969.

Senator Robichaud: Can we assume the spraying which has been used now will not affect fish life, because in all these areas there are streams which have salmon or trout. Can we assume the spraying being used will not affect them or that its use to an extent that will not damage.

Dr. Prebble: The materials being used now are released for operational programs after careful experimentation in the field, involving fisheries, scientists, wild life scientists and foresters. In the past toxicological investigations have also been carried out. The materials used are not stated to be beneficial to wild life populations, but they are stated by responsible scientists to be not sufficiently damaging to warrant the prospect of heavy loss of timber. This is the kind of compromise I speak about.

The forestry people, if left completely free, would bring back DDT, which is the cheapest and most effective residual insecticide; but they walked away from DDT for the very reason very reason that it was causing trouble to the fisheries people.

Some of the organophosphates cause concern to the wildlife people and at one stage of the discussion it was not the fisheries people versus the forestry people, but the fisheries people versus the wildlife people, as to the material to be used. That points up the necessity for compromise at every stage.

Dr. Needler: I think an answer to Senator Robichaud's question might be framed in this way, that the measures can quite confidently be expected to prevent such losses as occurred about ten years ago which caused the damage to salmon in some Miramichi areas, which amounted to over 35 per cent. I do not think this can be expected now.

Senator Bourget: I understand that you have laboratory tests for wood, to find the strength of the wood.

Isn't that kind of work done also by the National Research Council? I understand they have also a branch which looks into construction material and particularly wood? Isn't there a duplication of work there or are you doing different research?

Dr. Prebble: The National Research Council has a division of building research, concerned with all sorts of building materials, heat loss, vapour loss, fire resistance and things of that kind. We have a forest products laboratory which is working very closely with the division of building research in those aspects of construction involving wood. We work also with the CMHC with reference to standards and specifications. I would say that there is no duplication.

Senator Bourget: There is no duplication, because I would say the NRC is well organized in regard to research and tensile strength.

Dr. Prebble: We are working in close collaboration in our work with the division of building research and also the CMHC.

Senator Bourget: In regard to technical papers, are they all published in French and English?

Dr. Prebble: Not all are published in both languages. Some are published in French with an English abstract, some are in English with a French abstract. Some are published in both languages, English and French. Also, I have to say that some are published in English only. One of our chief problems is keeping up with translations and it is impossible at the present time to have enough translators capable of translating technical papers from English to French, to keep up with the flow of material.

Senator Bourget: This is the same problems which have been facing the NRC, that they have not got enough translators for technical papers like that.

The Chairman: On page 65, under the heading of forest products, you list what have been in recent years the most successful research products, and this information of course was given according to our own guidelines. How many of these successful projects have found application in industry?

Dr. Prebble: The first example refers to non-destructive tests which are quite extensively in use at the present time. As a matter of fact, the program was designed very closely with the industry people. In the second example, we have very close collaboration with the sawmill industry and kiln-drying program.

The Chairman: Are they applying it?

Dr. Prebble: Yes. Inspecting marine piling is a program going on quite extensively in the west, and this year also in the Gulf of St. Lawrence and in the Bay of Fundy and in eastern waters. Number (iv) has been developed in our forestry department, and used in the plywood industry in British Columbia for detecting hidden flaws. Number (v), new processes and facilities for manufacturing particle board, is a co-operative project between our laboratory and the industry. I would say these projects are extensively developed and used by industry—I would not say by every industrial plant, but by ones which are quite anxious to use results of research and development.

Senator Robichaud: In connection with number (iv), has the Department of Forestry anything to do with obtaining the type of glue which was water resistant and permitting the use of plywood in wooden shipbuilding, such as they use now in good sized ships for keels and other large sections of the ships which required heavy woods?

Dr. Prebble: I cannot give a specific answer to that question, but I can say that in our forest products laboratory a very active program is concerned with the durability of glue bonds, especially in plywoods and also in laminated timbers. That is an important part of the program, in which an attempt is made to get what you might call indicative tests that will provide a valid assessment of long-term service performance, in other words, all sorts of speed-up tests which will give the answer in a few months as to what would normally happen over a period of years in service. But I cannot answer the question specifically as regards the wood members in ships.

Senator Robichaud: It is certainly being used now where they require timber which is not as available as before, they use laminated plywood for keels, or in a section of the ship which requires heavy timber.

Dr. Prebble: I know that our Vancouver laboratory has been working closely on the question of laminated timber, in design, strength tests, and performance tests. The part I cannot answer is whether it had specific reference to laminated timber used in ships.

Senator Robichaud: My reason for asking the question is as to what security the builders have that it will last in areas of salt water where these ships would be used.

Dr. Prebble: I will take note of the question and see if we can give you an assurance on that.

The Chairman: How many of the projects which are not listed here—you have listed only five, at our request—but in this field of forest products, do you think there would be many other projects which have received application in industry?

Dr. Prebble: Yes, indeed. One of our chief tasks was in disciplining ourselves to this list you have asked for. We had a hard time in answering the question on the five basic projects. This is elaborated in more detail later on towards the end of the report, about page 100. We had a very hard time on this because we failed to list many useful things because they were exceeding the number 5. I think the answer to your question is generally "Yes", although we don't claim that everything that comes out of research programs is suitable for application. We could have developed another 50 probably.

The Chairman: Then you give us on page 43 your total research budget and I wonder if it would be possible to know what is the share of the total department budget being devoted to research and development, let us say, directly or indirectly, supporting staff, etc.

Dr. Prebble: Well, Dr. Needler can tell us about the breakdown.

The Chairman: I am not dealing with Fisheries now, only with Forestry.

Dr. Prebble: We have a very small staff complement which is not engaged in research effort. I think there is a breakdown that might help us on pages 68 to 72.

The Chairman: But these deal only with research activities.

Dr. Prebble: That's right. Practically all our activity is research. We have a small group of people carrying out service functions on federal land such as Camp Gagetown and Camp Petawawa. These would fall in the liaison activity which makes up 8 per cent of our total so that something like 8 per cent of our total is on service functions.

The Chairman: So that you would say that about 92 per cent of the budget of your Department of Forestry is devoted to research?

Dr. Prebble: Yes, but you have to look at one other item.

The Chairman: Let us say scientific activities including data collection and all these things and information.

Dr. Prebble: But we have about 19 or 20 per cent of our staff who are involved in what you might call administrative functions in support of research. For example we require an engineering staff and a staff to maintain the buildings and so on.

The Chairman: That is what I would call indirect. It would be right to say about 92 per cent of your budget is devoted directly or indirectly to scientific activities?

Dr. Prebble: Actually a little better than that because of this 8 per cent some does apply to scientific activities, so you might say that 95 per cent would be nearer the mark.

Senator Robichaud: The figure for 1968-69 is $43 million, and the federal Government provides 42 per cent of the current Canadian outlay on forestry and forest products research and development. So if $43 million is the total research outlay for forestry in Canada, the figure would come to a little lower than about $18 million. I am doing some quick arithmetic here.

Dr. Prebble: The figure just quoted, about $18 million, is exclusive of capital. The reference to $23 million includes the capital program as well as grants program.

Senator Cameron: Mr. Chairman, there is one question that looks like bad news on page 117, "Control of dwarf mistletoe in lodgepole pine stands", in view of the large areas of Alberta and British Columbia which are covered by lodgepole pine. And you say that the annual loss of pine growth in Alberta alone is 9 million cubic feet—is this a situation which is getting worse rapidly or is it likely to get worse rapidly or can something be done to stop it?

Dr. Prebble: I think much can be done to stop it. It is a question of what you might call very detailed forest management. The process of dwarf mistletoe infection from one generation to another depends essentially on badly diseased trees which carry the parasitic plant. If diseased trees are left behind they drop mistletoe seeds on young second growth trees that come in naturally, and very heavy infection results. If when the old stand is being removed, diseased trees that may be valueless are taken away or destroyed, you can much more easily control the dwarf mistletoe. This is getting started now, but it is only a very recent program.

The Chairman: I remember some years ago Dr. Steacy was criticizing quite strongly the organization of teaching in the universities with respect to sciences and specializations related to biology and he was regretting at that time the separation between fundamental biology and the specialization, let us say, in agriculture and forestry and even included also medicine. Do you think that this kind of specialization and separation in our universities is accounting for the fact that a lot of our people in forestry, for instance, have not had basic training in our universities in the field of biology. Many of them after graduation from forestry school had to go and specialize outside to get some of that basic training.

Dr. Prebble: I could not agree with you more, because when I graduated from forestry school I went to McGill for post-graduate work and had to do a qualifying year despite the fact I was an honour student.

The Chairman: Then in the same vein if there would be some better integration in our universities for teaching of the sciences related to biology, would it not be a good thing also in the field of research if we had perhaps better integration of our scientific effort in those fields, forestry, fisheries—and this is an integration which has been made recently but apparently was not very much desired—and also agriculture. It seems to me that on the basis of all these research projects and all the research activities you have to rely in these three fields very heavily on good research in the field of biology and work in related sciences but mainly biology.

Dr. Prebble: I think the situation is changing progressively and quite rapidly in the training in the forestry schools now. We must remember that until quite recently the forestry schools were in a sense designed to turn out graduates to serve administrative needs in the provinces and the industry. And the turnout of research people in the forestry schools is of comparatively recent development—I would say the last 15 years. That, of

course, is changing the complexity of the instructional courses in forestry schools and they have changed very dramatically in the last few years. That situation is getting much better than it was and it is by virtue of having professorial staff in the schools interested in research. They are much more likely to collaborate effectively with the basic science courses in the universities and working out collaborate programs.

When it comes to the second part of your question I think I should speak to this. I want to point out that in a mission-oriented program you cannot be too far separated from the ultimate client unless you are going to cease to serve him. There is a great deal of collaboration across departmental lines and interdepartmental committees and study groups of that kind, but basically if you are going to serve the forest community the research has to be built around the industry and the forest community you are serving. I thought you might want that question answered.

The Chairman: For instance, when we had the Department of Agriculture before us they told us it was of course included in their brief and they were doing quite a bit of research in tree growing and almost all kinds of trees as well as ornamental trees, and that was in so far as their information service, for instance in cities, was concerned. This was a very big operation as far as they were concerned. How is this integrated with your own activities?

Dr. Prebble: The Department of Agriculture has an extensive program in horticultural plants and shrubs and of course fruit trees.

The Chairman: It would seem that the research problems would be in some instances at least quite similar.

Dr. Prebble: From the physiological point of view, you are quite right. They are growing such trees for heavy fruit production which means you have a different cultural treatment, but basically the physiological base would be the same. We have an interdepartmental committee on entomology and botany as between the forestry branch and the Department of Agriculture which meets at least once a year, sometimes twice a year, and reviews programs with some collaborative effort going on continuously between the two establishments at headquarters, and also in the field as between one establishment and another.

In many cases it is made very easy because one substantial element of the forestry branch had its birth in the Department of Agriculture and collaboration is very easy.

The Chairman: I remember when I was an assistant deputy minister in the Department of Northern Affairs and National Resources and that service in agriculture was moved to the Department of Northern Affairs.

Dr. Prebble: That is right.

The Chairman: We started to move services even at that time.

Dr. Prebble: As far as the forestry branch was concerned, and that was the question of transfer that Senator Cameron referred to, I think there has been tremendous progress.

The Chairman: When you organize your research programs in the field of biology do you make sure that the Department of Agriculture does not do the same thing or if they want to do the same thing and you decided you have to do it, is there a danger that there be some unrelated parallels?

Dr. Prebble: I can give you two or three illustrations that might answer the question. There is a so-called national committee in Canada which is concerned with tree improvement. One element of the Department of Agriculture which has been very active in this field is located in Indian Head for the development of plants for shelter belts in the prairie region. These people meet together periodically to review programs and our people in the prairie region work very closely with that establishment in Indian Head.

A second program was put into effect some years ago when actually one element of the forestry branch was still in the Department of Agriculture and they became very active in the program of breeding elms for resistance to the Dutch Elm disease. A strong collaboration was established in that the horticulture element of that program was handled by the Department of Agriculture. The disease-resistant element were handled by members of the forest biology division, which is now one part of the forestry branch. I do not think we encounter a situation where we are duplicating or overlapping, but there would necessarily be physiological work in forestry dealing with different species under different forest conditions. At the same time there is physio-

logical work going on in the Department of Agriculture in relation to horticultural varieties and fruit trees. The competent scientists in those areas are conscious of what other people are doing and collaborating rather than duplicating.

Dr. Needler: Mr. Chairman, I believe it is a safe generalization that while a lot more fundamental research needs to be done in Canada, we are even farther behind in Canada in the application of this research. Maybe this is the most difficult field or the field in which we need to look for most improvements.

I used to be a scientist once and I started off with the intent of being a research scientist and I think that in fundamental scientific matters there is an organization of science, separate from our institutions. There are various mechanisms by which fundamental research scientists, in similar subjects, learn of one another. They correspond with one another and are aware of other's publications which is pretty effective.

I think the most difficult field is the flow of ideas and information from fundamental science through applied science to practice. I believe that this supports what Dr. Prebble said, that you have to have the research fairly close to your client.

The Chairman: I would certainly agree with this, but it can be done in various ways and still remain close to the users.

Dr. Needler: Yes, but I think this is the most difficult field to have research well applied and in general of course government research is well applied. Of course we do have the support of NRC for fundamental research as well as our own activities and it is all mission-oriented or applied. It is for the purpose of obtaining improvement in a certain field. I believe that this, being the difficult problem, it is necessary to sort of partition the activities and keep them close to the application, however, I thought I would like to make that comment.

Senator MacKenzie: This question may have been asked and if so you can disregard it. In view of the extent to which lumber is used in the construction industry in Canada and other countries as well, has much been done or is much being done in respect of making wood products used in production fire resistant, by impregnation or something of that kind?

Dr. Prebble: Yes, that program is being carried out now, sir. With respect to shingles, for example, that program is being conducted in our western laboratory. There are programs also in connection with the use of fire resistant materials on plywood, which is very important, especially in the European market because they stress fire-resistant qualities in plywood. There is also a heavy program on the use of other materials to prevent borers and stains and decays in timber, as part of the timber preservation program.

Senator MacKenzie: Is this an expensive addition to the price of lumber? I ask that because I have been told that wood that is properly treated is about as fire resistant as any other building material you can use.

Dr. Prebble: I think I saw some figures. It would be nice to be able to anticipate a question of that kind, so that one could store the mind with figures. I think I saw some figures a day or two ago or a week or two ago that indicated that one of the preservative treatments or anti-fire treatments worked out at a cost of adding 1 cent per square foot, in the cost of plywoods. That would be not at all prohibitive. There is no question that successful fire preventive treatment would not price wood out of the market.

Senator Cameron: Is it not true that there is increasing use of laminated beams today, and these are much more fire resistant than the equivalent of steel?

Dr. Prebble: I think the situation is that in a severe fire where steel is used for beams or rafters you get distortion through twisting and damage is done in that way; whereas destruction of a wooden beam is very slow in fire and the fire may be put out with a little charring, but without excessive destruction.

Senator MacKenzie: With respect to the question of teaching in the faculty of forestry, I would like to point out that twenty or thirty years ago the main concern was to produce and market wood; and that forest engineering or the equivalent attracted more of the young men than did silviculture and science, for the simple reason that that is where the jobs were provided.

The change in that began to take place ten or fifteen years ago. To the best of my knowledge, those university faculties of forestry are much more interested and concerned with and oriented to scientific work and research than was the case 20 or 30 years ago.

The Chairman: I quite agree with you, senator. But while they are doing that and while the faculties of agriculture are doing the same, are we not organizing and duplicating educational facilities in the field of forestry? Some 15 or 20 years ago there was no problem of duplication because the faculties on forestry were not interested, or at least not very interested in biology, but now that they are interested, the program may certainly develop.

Senator MacKenzie: This is very much more a matter of organization of the curriculum of the disciplines of the department in the schools.

The Chairman: We will not solve that problem today.

I wish to thank, on your behalf, our guests of today. Perhaps a special word of thanks should go to Dr. Prebble, because we all know that we will see Dr. Needler again tomorrow when the Department of Fisheries will be before us. Thank you very much.

Senator Cameron: Before we adjourn, Mr. Chairman, I have the impression, in relation to the total value of forest industry in Canada, and it is a very high percentage of the export market, but we are spending a relatively small proportion compared with other industries in forest research and research and development. I would think probably this needs to be given a very hard look in terms of our recommendations because this is a very large industry. It is of vital importance to the economy of the country. The amount you see mentioned here and there for assistant graduate students and for research projects is certainly falling far below the target of the proportion of the GNP for research activities.

Senator Bourget: The amount mentioned only shows the amount spent by industry and not what is spent by all governments, our government and provincial governments.

The Chairman: The amount spent by the provincial governments would be about 4 per cent, according to their figures.

Senator Cameron: This is an area at which we should take a really hard look.

Senator Bourget: I think they were spending more. Here is only the figure for research, but they must be spending more money on other activities dealing with such things as afforestation.

The Chairman: That is not a scientific question.

The committee adjourned.

APPENDIX 13.

DEPARTMENT OF FISHERIES AND FORESTRY

BRIEF ON FORESTRY RESEARCH

TO

THE SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

FORESTRY BRANCH

DECEMBER

1968

DEPARTMENT OF FISHERIES AND FORESTRY

BRIEF ON FORESTRY RESEARCH

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FORESTRY BRANCH

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SUMMARY AND MAIN CONCLUSIONS

The Forestry Branch of the Department of Fisheries and Forestry comprises forestry program units which were transferred from the Department of Forestry and Rural Development at July 12, 1968.

2. The British North America Act, paragraph 5, Section 92, assigns to the provinces exclusive legislative rights regarding "the management and sale of public lands belonging to the province and of the timber and wood thereon". Municipal and privately owned forests, which amount to about 10 per cent of the provincial total, are also held to be within the legislative competence of the provinces under Section 92. Thus, it is clear that the management of Canadian forests, other than those in the Territories and on federally administered lands within provincial boundaries, is under the jurisdiction of the provincial governments.

3. However, as indicated by the following data, the forestry and forest-based industries constitute a major segment of the Canadian economy, particularly with respect to international trade. They provide 4.84 per cent (1965 data) of the Gross Domestic Product, employ about 3.0 per cent of Canada's labour force, and account for between 20 per cent and 25 per cent of the total value of exports. Two-thirds of the wood cut in Canada is sold abroad in a large number of markets and in a wide variety of products. Thus, it is clear the welfare of these industries is a matter of prime concern to Canada as a whole. In these circumstances, and by virtue of Section 91 of the BNA Act, the Government of Canada has legislative authority and indeed a definite interest and responsibility in a number of matters affecting the forest industries. Hence it may influence indirectly the use and management of the forest resources on which those industries are based. These areas of jurisdiction include trade and commerce, financial matters such as taxation and incentives to industrial development, weights and measures, and interprovincial and international transportation. Federal action is also needed to deal, in close cooperation with the provinces, with the increasing involvement of Canadians in the work of international forestry organizations and other aspects of world forestry.

4. Scientific forestry was unknown in Canada at the time of Confederation. It is thus not surprising that the BNA Act makes no reference to responsibility for forest research. The Act does, of course, vest residual

powers in the federal government. With the full cooperation of the provinces and industry, and for their benefit, the federal government has in fact conducted research in forestry and forest products for many years.

5. Since 1949, the Minister responsible for forestry has been authorized to carry out certain types of research under the Canada Forestry Act. This Act was repealed by the Department of Forestry Act, 1960, as amended by the Government Organization Act, 1966, and renamed the Forestry Development and Research Act. This last Act gave the Minister mandatory responsibility to provide for research relating to the protection, management and utilization of Canada's forest resources and forest products and permissive authority to undertake further active measures in these fields.

6. This research is carried out by the Forestry Branch, which comprises seven regional establishments, two forest products laboratories, and seven institutes. The basic objective of this program is to provide the scientific, technological and economic information and services required by federal and provincial government agencies and private industry, to assure the maximum contribution from the forestry sector to the industrial development and the economic growth of the country. The means taken to achieve this objective may be grouped conveniently under (a) research and development, which includes surveys, research, pilot-scale operational trials and demonstrations of research findings, associated programs for the dissemination of technical information, and extensive consultative and advisory services; (b) economic studies; and (c) operational programs. These closely interrelated program activities are directed toward the two essential components of the forestry sector, that is, the forest resources of the country and the forest products industries. The objective of program activities relating to the forest resources is improved efficiency in management, protection and productivity. In the forest products field, the objective of the Department's programs is increased efficiency and maximum utilization in timber harvesting and in conversion of wood to saleable products.

7. To undertake its responsibilities, the Forestry Branch has a personnel complement of some 1970 man-years. The budget for 1968-69 is for:

Operation and Maintenance		$18,271,025
Capital		3,697,000
Grants		1,516,000
	Total -	$23,484,025

8. There has been a notable change in recent years in the nature of the research program of the Forestry Branch in that a better balance is being achieved. Formerly, the Branch operated largely at the interface between basic and applied areas. Now more attention is being given to the applied and developmental areas. These are the areas where many of the more immediate problems faced by the forestry community are found, and where earlier contributions may be made to forest productivity and the national economy.

9. Greater emphasis on practical problems is reflected not only in the trend in the scientific research program, but also through employment of officers in all establishments to undertake more work in liaison, demonstration and application of research results. Another related component is the allocation of more funds for contract work with outside agencies for developmental types of research.

10. The Branch has sub-divided its program into seven major activities, each of which may have several sub-activities and many projects. In brief outline, these are as follows:

(a) Activity 1 is Resource and Management Research which embraces forestland classification, forest soils, forest inventory and mensuration, silviculture and tree biology. These are interrelated through their common practical objective of maximizing forest production. While the primary objective of the activity is the ensuring of a continuing and improving supply of wood, increasing attention is being given to research that will assist management in making less tangible but vital contributions from the forest resource to recreation, wildlife preservation, and protection of water resources. This activity is conducted at all seven regional forest research

establishments and at two forest research institutes. It currently occupies 23 per cent of the staff.

(b) Activity 2 is Forest Protection Research which comprises work on wildfire, insects, and diseases that play major roles in the cycle of growth, decay and rejuvenation of the forests. It is concerned also with controlled fire as a silvicultural tool. Protection problems are most acute in the softwood forests which contain our major commercial species. Softwood forests are most susceptible to fire, and also rate high in vulnerability to attack by insects and diseases, especially the older mature stands. Those succumbing to insect and disease attack become high fire hazards, hence there is a strong interrelationship among these forest influences. An increasing effort is also being directed to protection problems encountered in extensive forest plantations.

The Branch objective in forest protection is to provide the basic information needed by forest managers on the most effective means to provide protection against fire, insects and diseases.

About 30 per cent of the staff is engaged in the protection activity. They are stationed in all regional forest research laboratories and three institutes.

(c) Activity 3 is Forest Products Research which is carried out mainly in special laboratories at Ottawa and Vancouver. The objective is to develop, collect, and disseminate information on the properties, behaviour and use of wood which will lead to increased efficiency in the harvesting and processing of the forest resource, and to its maximum utilization.

The research effort uses about 11 per cent of the Forestry Branch staff.

(d) Activity 4 is Forest Economics. The objective of the activity is to provide economic criteria and information that will assist in making policies and decisions respecting forestry in both the private and public sectors, and to develop economic understanding of forest-based activity through research and analysis of existing and projected practices. This work is done in several regional research laboratories and in an institute

that is devoted to economic studies of national interest. The economics program is closely coordinated with the research in other major activities, and occupies about 3 per cent of the Forestry Branch staff.

(e) Activity 5 related to liaison, development and forest services work and is an important component of functions relating to application of research findings. The four major aspects are (i) liaison with the various agencies to communicate research information, and, also, to learn of the problems of the user; (ii) development work whereby projects are carried beyond the stage of research findings and the potential for practical application is demonstrated to the ultimate user; (iii) advisory or consultative services designed to assist governmental agencies and the private sector in developing methods for more efficient management and use of the forest resources; and (iv) operational services performed on certain federal lands, e.g. Base Gagetown. These involve all scientific or professional personnel and about 8 per cent of the total staff works exclusively in this field.

Besides the liaison and demonstration work just mentioned, research results are communicated through articles in scientific and technical journals, forestry trade magazines, special regional newsletters and departmental publications. Participation in symposia, workshops, conferences, etc., is another widely used method of communicating research results. Direct contact is also maintained between research staff and interested or potential users.

(f) Activity 6 is Research Services. The largest sub-activity consists of biometric research services and scientific consulting and data processing services for the Branch as a whole. Library services are provided by a Headquarters library at Ottawa and numerous smaller libraries at other Branch establishments. Scientific editing services are maintained to provide editorial processing for scientific and extension publications in English and French. Other research services include photographic and drafting services at Branch establishments, in addition to the central graphics unit in departmental headquarters.

This activity occupies about 6 per cent of the Branch staff.

(g) Activity 7 consists of program management and coordination,

and administrative and maintenance services at Branch establishments. This activity requires 19 per cent of Branch staff. This group is responsible for directing, coordinating and controlling the Branch forestry program and, in addition, provides essential support services at Branch establishments from coast to coast.

11. The Forestry Branch program activities outlined above are carried out in close cooperation with other federal departments, provincial agencies, universities, and industry. To aid in establishing realistic practical objectives and in maintaining appropriate balance in the program, the Branch has taken the initiative in organizing regional advisory committees for the forest research program, as well as subject-oriented research program committees in the forest products field. There is also a National Advisory Committee on Forest Products Research to advise the Deputy Minister on broad trends and research needs in the forest products industries. Consideration is being given to expanding the latter to include the whole area of forest resources research.

12. The membership of regional advisory committees on forest research represents the pertinent provincial forest services, other appropriate governmental or regional agencies, forest industries associations, universities, and the Forestry Branch. The committees establish criteria for evaluating major forestry problems of the region and assign research priorities; advise on establishment of broad programs and required resources, and review progress; and advise on coordination of Forestry Branch programs with those of other agencies.

13. The research program committees that assist the directors of the forest products laboratories have memberships drawn from the relevant wood-using industries. Their primary function is the review of existing programs as to technical and economic significance, and assessment of proposed new programs and projects. They also provide information on industrial developments that may influence program planning.

14. The National Advisory Committee on Forest Products Research is composed of seven senior executives of the forest products industries.

Each member is named by an association representing a field of interest covered by one of the research program committees. They advise the Deputy Minister on industry trends and particular areas requiring additional research. The Committee has also been concerned with the need for development of economic criteria needed for appraisal of research project proposals, and with communication of research results to the user industries.

15. Program review on an overall level throughout the Branch is a continuous function exercised by the Directorate of Program Coordination in consultation with establishment directors and their senior research staff. In addition, the Branch Program Committee, chaired by the Assistant Deputy Minister (Forestry) and comprising the directors of all research units and the program coordinators, meets twice annually to review broad program allocations, and needs for personnel, funds, and major facilities. Directors of departmental administrative services divisions attend as observers and advisers. The Committee reports to the Deputy Minister.

16. In addition to its "in-house" research program, the Branch provides extramural research grants to university staff members for projects that complement or supplement the Branch program. There is also a small program of contracting out developmental projects and operational trials in support of intramural programs. These contracts are usually with representatives of industry, universities, consultants, or provincial agencies.

17. In 1967-68, the Branch initiated a program of operating grants of $40,000 to each of the four Canadian forestry schools. The purpose is to strengthen their research activities, enable more advanced forestry students to obtain graduate training in Canada, increase the number of qualified forestry personnel in Canada and add to the fund of knowledge related to Canadian forestry programs.

18. It is intended that Forestry Branch support of research in the universities, and especially in the Forestry Schools, will be increased progressively. It is also expected that the Branch will be making greater use of professional consultants on specific short-term investigations in future program development. However, it should be noted that such activities

are complementary to, and not a substitute for, continuing comprehensive programs of surveys, appraisals, research and development, and advisory and consultative services such as carried out by the Forestry Branch on a national scale.

19. The more difficult problems in forestry are typically multi-faceted involving several disciplines, and are of a long-term nature. The importance of apparently similar problems frequently differs significantly in different regions of Canada, and in a given region with the passage of time. A great deal of effort is required in preliminary survey and appraisal in order to define problems and to identify facets that may be amenable to solutions through research. It is frequently essential to have interrelated survey and research programs underway simultaneously in several regions, and continuity of effort and comparability of results are vitally important. Close liaison and coordination are needed to direct research efforts toward desired objectives, and to facilitate effective use of research findings in practical applications. Leadership on a national scale is required for large programs to which numerous agencies make their respective contributions, be they provincial departments, industrial associations, universities, regional establishments of a federal agency such as the Forestry Branch, and so on. Examples of such programs to which the Branch is contributing and at the same time providing national leadership include forest fertilization, harvesting problems in the forest industry, the use of aircraft as water-bombers in fire control, and forest pest assessment and control.

20. To ensure the effective performance of comprehensive research programs, leadership functions, and advisory and consultative services at the regional and national level, the Forestry Branch must have assurance that personnel, funds and facilities will be available in adequate supply over prolonged periods. Lack of such assurance impedes development of appropriate long-term programs and cooperative arrangements, and tends to diminish the future supply of Canadian forestry research personnel being trained in the universities, owing to uncertainty about employment prospects in research after graduation.

21. The present level of research and development expenditures in Canada on forestry and forest products amounts to about $43 million, exclusive of capital outlays. This represents less than one per cent of the gross value of woods operations and factory sales from wood-based industries. However, in the experience of other industries and other countries, economic benefits continue to increase with research expenditures up to two or three per cent of the total gross values derived from such industries. The federal government provides about 42 per cent of the current Canadian outlay on forestry and forest products research and development; the industry, 51 per cent; provincial governments, 4 per cent, and universities about 3 per cent. A progressive increase in the federal government outlay, even if that should result in a greater percentage of the total Canadian expenditures in this field, would not be inconsistent with the scale of benefits to the Canadian economy and the national treasury resulting from forestry and the forest-products industries.

PROGRAM OF THE FORESTRY BRANCH

2.1 Organization

2.1 (a) The organizational structure of the Forestry Branch is illustrated in the accompanying block diagram. Several organizational features represent a transitional phase in the transfer of the Branch and elements associated with the forestry program, from the Department of Forestry and Rural Development to the Department of Fisheries and Forestry. These are noted below:

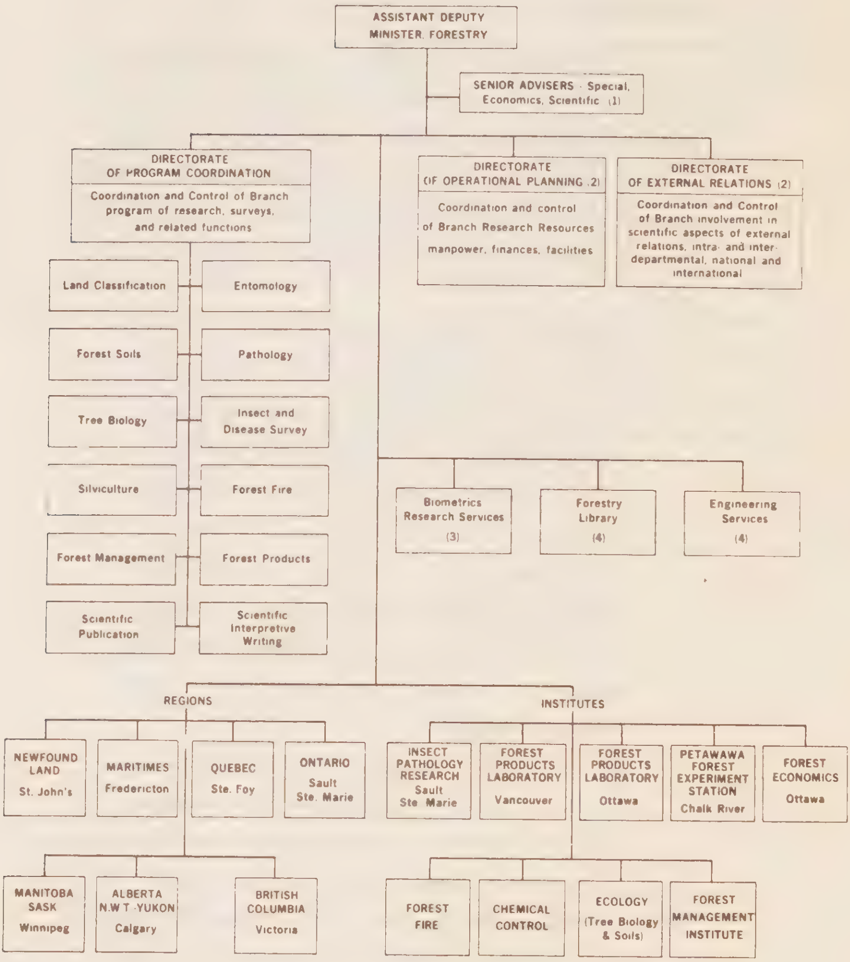
(1) Three senior advisers, formerly on the staff of the Deputy Minister of Forestry and Rural Development, transferred with the Forestry Branch to the Department of Fisheries and Forestry and are currently serving as advisers to the Assistant Deputy Minister (Forestry). When the organizational structure of the new department is resolved, it is expected that members of the advisory group will be re-established in senior staff functions associated with the Deputy Minister, or in senior executive posts within Forestry Branch Headquarters.

(2) The Directorate of Operational Planning and the Directorate of External Relations are small but essential executive units to be set up in Forestry Branch Headquarters.

(3) The Biometrics Research Service has been associated with the Forestry Branch since inception of the service, but will be separated from the Branch to form the nucleus of an enlarged unit to serve the Department of Fisheries and Forestry as a whole.

(4) The Forestry Library will be separated from the Branch and incorporated with the Fisheries Library to form an integrated library for the whole Department. The Engineering Service, which became attached to the Forestry Branch at time of separation from the Department of Forestry and Rural Development, will be separated from the Branch and merged with similar elements to serve the Department of Fisheries and Forestry as a whole.

ORGANIZATION OF THE FORESTRY BRANCH



Foot notes (1) to (5) See text

(5) The organizational structure and reporting arrangements of regional research establishments and institutes were not influenced by the transfer from one department to another in 1968. They are responsible for carrying out the scientific research programs of the Forestry Branch.

2.1 (b) The reporting channel followed by the Forestry Branch is simple and direct, that is, the Assistant Deputy Minister (Forestry) reports to the Deputy Minister on forestry program, and the Deputy Minister to the Minister on fisheries and forestry programs of the Department. This direct reporting relationship is not influenced by the existence (a) of advisory committees or interdepartmental committees in various subject-matter fields, at the research laboratory or Branch level, or (b) advisory committees on forestry or forest products fields at the Deputy Minister level.

2.1 (c) The Organization Chart in Section 2.1 (a) shows that scientific activities in the Forestry Branch are conducted in seven Regions and nine Institutes and that the whole program is coordinated and controlled by a group of specialists in the Directorate of Program Coordination. All Regions are organized along similar lines under a Director and Associate Director. This is demonstrated by the Organisation Chart for the Maritimes Region (Appendix 2.1)c)i). The organization of most of the Institutes is similar to that for the Forest Management Institute, shown in Appendix 2.1)c)ii. The organization developed by the two Forest Products Laboratories, which are larger than the other Institutes, is shown in Appendix 2.1)c)iii.

2.1 (d) Formal agreements regarding scientific activities between the Forestry Branch and organizations outside of Canada are as follows:

International Poplar Commission

2. Canada is one of the 25 member countries of the International Poplar Commission which operates under Article XIV of the Constitution of the Food and Agriculture Organization of the United Nations. Membership in the Commission by FAO member nations is effected by the deposit with the Director-General of FAO of an instrument of acceptance of the Convention placing the International Poplar Commission within the framework of FAO. The document signifying Canada's formal acceptance was signed on November 15, 1962, by the Secretary of State for External Affairs, and thus strictly speaking is not an agreement between this department and FAO, but the Forestry Branch is responsible for Canada's participation in the Commission's work. The International Poplar Convention is the only such agreement relating directly to forestry to which Canada has become a party.

3. The Convention sets forth the functions of the Commission, which are in brief: to study all aspects of poplar and willow cultivation, to promote the exchange of ideas and materials, to arrange joint research programs and meetings, and to make recommendations to FAO and to National Poplar Commissions or other appropriate national bodies in member countries. The Forestry Branch has been designated the appropriate body for Canada.

4. Other terms in the Convention provide for conditions of membership, the holding of sessions, the establishment of an executive committee and subsidiary bodies, the adoption of rules and procedure, finances, and official languages, which are English, French and Spanish. The Commission has established Working Parties on Poplar Utilization, Poplar Diseases, and Poplar Insect Pests. The Thirteenth Session of the Commission was held in Montreal in September, 1968.

North American Forestry Commission

5. The North American Forestry Commission is one of the six Regional Forestry Commissions of FAO established under Article VI of FAO's Constitution for the purpose of advising on the formulation and implementation of policy and coordinating the implementation of policy on the regional plane. These Commissions are governed by Rules of Procedure approved by the FAO Conference, and their method of establishment is rather less formal than the Convention which governs the International Poplar Commission.

6. The member countries of the North American Forestry Commission are Canada, the United States and Mexico. The rules of procedure provide that nations which are members of FAO and eligible from a geographic standpoint may become members of the Commission by notifying the Director-General of FAO of their desire to do so. The rules also deal with the election and appointment of officers, the holding of and agenda for sessions, admission of observers, votes and procedures, records and reports, the establishment of subsidiary bodies, and finances. English and Spanish are the official languages of the Commission.

7. Despite the policy implications of the Regional Commissions' terms of reference as contained in FAO's Constitution, much of the work of the four subsidiary bodies of the North American Forestry Commission is concerned with technical and scientific matters, primarily for the purpose of advising on suitable practices and action in regard to specific problems. These bodies are Working Groups on Forest Insects and Diseases, Forest Fire Control, Forest Tree Improvement, and Wildlife and Outdoor Recreation.

8. The Working Groups usually meet more frequently than the biennial sessions of the Commission. Canadian membership in them includes several representatives of provincial forest services and the private sector.

9. Canada will be host to the Fifth Session of the North American Forestry Commission in 1969.

Multilingual Forestry Terminology

10. The Joint Committee on Bibliography and Terminology of FAO and the International Union of Forestry Research Organizations is sponsoring the preparation of a Multilingual Forestry Terminology. The basic working language is English. French, German and Spanish versions are also contemplated or in progress, with the possibility of other languages being introduced later. Canada is actively concerned with the English and French Terminology Projects.

(a) English Terminology

The Governments of Canada and the United States are sharing the cost of the English Terminology Project. The Director and Editor (a former Director of the Commonwealth Forestry Bureau at Oxford, England) is under contract to the Society of American Foresters which was selected by the parties concerned as an appropriate non-profit organization to administer the Project. The United States Forest Service, representing the U.S.A., and this department, representing Canada, have separate agreements with the S.A.F. covering their participation. The Canadian agreement with the S.A.F., dated August 10, 1964, provides that Canada will contribute a sum not exceeding $25,000 (U.S.) to the Project during the five-year period beginning in the fiscal year 1964-65, by the end of which the work is expected to be completed. The S.A.F. agrees to conduct and report upon the Project, to divide expenses equitably between the contributing governments, and to refund any unused funds advanced. Besides assuming responsibility for leadership, supervision and scheduling of the work, the S.A.F. undertakes to bear any costs incurred in excess of the amounts contributed and to provide this department with 12 copies of the final report, which may be issued as a printed document for public use.

(b) French Terminology

Arrangements quite similar to the above are now being completed in connection with the French Terminology Project, to the cost of which Canada, France and Switzerland are contributing. A retired officer of FAO's Forestry and Forest Industries Division residing in France is the Director and Editor and La Société des Anciens Elèves et Amis de l'Ecole Nationale des Eaux et Forêts de Nancy is to act as the administering agency. An agreement with the latter, along the lines of that with the S.A.F. for the English Project, is now being negotiated. Treasury Board has authorized payment of $30,000 (Can.) over a four-year period for this purpose. In order to get the Project under way and to facilitate negotiations with La Société, the Director and Editor was initially employed under short-term direct contracts with this department.

11. Besides financial support for the English and French Forestry Terminology Projects, the department arranges for the review by appropriate Canadian experts of draft material submitted by the Project Directors.

2.2 Organizational Functions

2.2 (a) The statutory functions and powers respecting scientific activities of the Forestry Branch are laid down in the Forestry Development and Research Act, which is the Department of Forestry Act, 1960 c. 41, as amended by Section 26 of the Government Organization Act, 1966. The pertinent Sections are contained in Appendix 2.2 (a).

2.2 (b) To implement its statutory functions and powers respecting scientific activities in forestry, the program of the Forestry Branch has been organized and designed to promote sound management, effective protection and maximum development of the forest resources of the nation, more effective utilization of wood, the development of improved products and the reduction of waste, and improvement of the competitive position of Canada's forest industries. The means through which the Forestry Branch seeks to achieve these program objectives include the conduct of surveys and basic and applied research in forestry, forest products and economics; pilot-scale operational trials and demonstrations; dissemination of the results of surveys, research and operational trials through reports and publications, "work-shops", technical consultative and advisory services, participation in the work of numerous standards committees and associations, and continuing liaison with provincial forestry departments and the forest-based industries; the provision of information on forest inventories and management planning to other federal departments responsible for administration of forested lands; and through provision of appropriate assistance to the provinces, under agreements authorized by the Governor-in-Council, to encourage specific forestry programs of exceptional importance.

2. For control and analytical purposes, the forestry program is broken down into seven "activities" defined as follows:

- administration and overhead, comprising managerial and supporting administrative service functions that cannot be allocated to other specific activities;
- resource and management research, comprising research programs on forest land classification, forest soils, forest inventory and mensuration, silviculture and tree biology;
- forest protection research, comprising research on forest fire control, insect and disease surveys, and research in entomology and pathology;
- forest products research, comprising research on the properties and behaviour of wood; protection of wood in service; structural applications of wood including panel products, containers, buildings and engineering works; harvesting, sawmilling, veneering and secondary conversion of wood; wood chemistry, pulping, glues and gluing, composite wood products;
- forest economics, comprising investigation, analysis and research relating to the forest resources and the forest-based industries, market and demand, production and management, and policy and legislation affecting utilization and protection of the forest resources;
- liaison, development and forestry services, comprising a number of "sub-activities" involved in transmittal of technical information to the owners and users of the forest resources, development work including pilot-scale trials and demonstrations, and the execution of management and protection operations on federal forested lands by agreement with the administering department; and
- research services, comprising research, consultative and operational services in the field of mathematics and data processing, library services, and scientific editing and photographic services, that cannot be allocated to other specific activities.

3. The execution of the forestry program is centred in seven regional forest research establishments, two forest products laboratories, seven research institutes, and the biometrics research and data-processing unit. (See chart under 2.1 (a)).

4. The seven regional establishments are responsible for the Forestry Branch programs of forestry research, surveys, development projects, consultative and liaison services in their respective regions.

5. There are two Forest Products Laboratories, one at Ottawa, the other at Vancouver. The Ottawa laboratory is responsible for research and services relating to forest products problems in provinces east of Alberta, the Vancouver laboratory for forest products problems of Alberta and British Columbia. Each laboratory has, in addition, special research assignments on a national basis, e.g. the Branch's activities in pulping are carried out in the Vancouver laboratory, and its activities in paints and coatings in the Ottawa laboratory.

6. There are a number of Research Institutes, as follows:-

(a) The Insect Pathology Research Institute at Sault Ste. Marie, Ontario, conducts research on use of insect pathogens in pest control.

(b) The Chemical Control Research Institute at Ottawa is responsible for research on use of insecticides and other chemicals in pest control.

(c) The Forest Fire Research Institute at Ottawa does research on fire danger rating systems and forecasting methods, basic studies of fire physics and chemistry and of meteorological influences on fire behaviour, studies of detection and suppression methods.

(d) The Forest Management Institute at Ottawa has a program of research on growth and yield of forest stands, forest mensuration and inventory methods, simulation studies of forest production and harvesting methods. Also, it provides consulting and operational services on federal lands.

(e) The Forest Ecology Institute at Ottawa carries out research on forest soils physics, chemistry, and microbiology, soils properties and degradation, nutrient uptake and fertilization; research on tree biology, including ecology and genetics. At present, only the initial elements of this Institute are in existence, and are accommodated on an interim basis at the Petawawa Forest Experiment Station.

(f) The Petawawa Forest Experiment Station at Chalk River, Ontario, is the location for research on silviculture, ecology, and tree breeding for improved strains resistant to pests; and fire research. It is responsible also for fire suppression and forest management services for the Canadian Forces Base, Petawawa.

(g) The Forest Economics Research Institute at Ottawa carries out research and surveys on forest resources and forest-based industries and makes cost-benefit analyses of research projects. Also, it provides technical information services to other units of the Forestry Branch.

7. The Biometrics Research Services at Ottawa is responsible for research and consultative services in mathematics, statistics and computing methodology, and performs data-processing and computing services on behalf of other units of the Branch.

8. The functions of the regional forest research establishments and the specialized research institute differ in that the former are multi-discipline units having comprehensive forestry programs and impelling regional responsibilities, whereas the research institutes are much more specialized in their respective, more restricted, disciplinary fields and have broad national responsibilities and functions but no specific regional responsibilities. There is, however, close collaboration between the regional establishments and the institutes in the development and appropriate sharing of work programs, the mounting of task forces comprised of regional and institute personnel for concerted attack on major problem areas, and like approaches to avoid duplication of effort.

9. Policy guidance, overall direction, program co-ordination and budgetary control are the responsibility of Branch Headquarters exercised through staff groups responsible to the Assistant Deputy Minister (Forestry).

2.2 (c) The Forestry Branch maintains close working relations with several organizations, in order to foster collaborative projects and avoid duplication of effort.

(i) Research contacts of this nature with federal agencies are, in some instances, given formal or semi-formal status through the operation of interdepartmental committees. The principal contacts that are related to scientific activity are as follows.

(a) Fisheries: studies of hazard to fish and other aquatic life resulting from use of insecticides in forest insect control; reduction of such hazard through modification of insecticide formulations, dosage rates, and time and method of application.

(b) Department of Agriculture: taxonomic studies of insects, fungi, trees and forest plants; use of parasites, predators and pathogenic microorganisms in biological control of insects.

(c) Department of Indian Affairs and Northern Development, Canadian Wildlife Service: studies of hazards to wildlife (birds and mammals) resulting from insecticide use; reduction of hazard through modification of formulations, dosage rates, and time and method of application; studies of forestry-wildlife relationships, such as effects of birds and rodents on tree seed supply, survival of seedlings in forest plantations, effects of silvicultural practices on wildlife populations.

(d) National Research Council: Associate Committee on Forest Fire Control; Associate Committee on Agricultural and Forestry Aviation, especially with respect to pesticide

application; International Biological Program; International Hydrological Decade; co-operation in research relating to building materials and methods; co-operation with National Aeronautical Establishment in developing instruments or techniques for forestry purposes, such as fire detection or suppression, and in aerial photography of forestlands or wildlands.

(e) Department of Energy, Mines and Resources: forest hydrology in relation to yield and quality of water supply from forested watersheds.

(f) Department of Transport, Meteorological Branch: studies of meteorology in rating and forecasting fire danger, and in modifying fuel conditions; weather modification (National Research Council also); and effects of weather and climate on forest ecology.

(g) Central Mortgage and Housing Corporation: in the development of new wood products, Forestry assesses performance of wood and, in development research, designs methods for proof-testing wood components.

(h) Department of Industry: provides scientific appraisal of forestry equipment developed under the Program for Advancement of Industrial Technology.

(i) Department of Trade and Commerce: Forestry gathers data in co-operation with the Dominion Bureau of Statistics on forests and forest products for such agencies as the Division of Forests and Forest Industries of the Food and Agriculture Organization of the United Nations, the Timber Committee of the Economic Commission for Europe, the Special Committee for Pulp and Paper of the Organization for Economic Co-operation and Development, as well as the FAO/ECE/ILO Committee on Forest Working Techniques and Training Forest Workers.

(j) External Aid Office: Forestry assists the External Aid Office in arranging instruction, some within its own establishments, mainly in technical rather than scientific forestry matters.

It assists in arranging for technical or scientific personnel to conduct surveys or give other technical assistance to developing countries. This includes provision of departmental personnel.

(ii) Staff of the Forestry Branch participate in co-operative research projects with forest industries, especially through the Research Program Committees of the Pulp and Paper Research Institute of Canada, and the Logging and Forestry Committees of the Canadian Pulp and Paper Association. Also, professional service contracts are developed with industry or consultants to conduct specific scientific projects. Numerous senior representatives of industry serve on Forestry Branch Advisory Committees.

(iii) The Branch has long had close relationships with universities, and these have grown substantially during the last few years. They take several forms, of which the most definitive are (a) participation of university staff members in Forestry Branch regional advisory committees on problem appraisal and program development; (b) extra-mural research contracts with university staff members; (c) operating grants to Canadian forestry schools to promote the development of graduate research programs in the schools; and (d) appointment of Branch research officers to honorary professorial status for supervision of graduate thesis programs and giving of short lecture series in specialized subjects.

2. Extra-mural research contracts with university staff members are designed to complement the in-house research program of the Branch, and to take advantage of special research competence and facilities available in many university departments. The contracts are usually for a 3-year term and are subject to careful selection, review, and financial control. These contracts cover all major fields of forestry research, with the greatest number in forest products research. The applications for such assistance have greatly exceeded funds available ($200,800 in 1968-69).

3. The operating grants to the four Canadian forestry schools were initiated in 1967-68, in the scale of $40,000 per school. The

purpose is to strengthen research activities of the schools, enable more advanced forestry students to obtain their graduate training in Canada, increase the number of qualified personnel needed to meet the demands of the forest community, and add to the fund of knowledge related to Canadian forestry problems. The results of the first year's program have been very encouraging, and continuation of the grant program at the same level ($160,000) has been provided for in the 1968-69 budget.

(iv) The Forestry Branch does not monitor scientific activities outside Canada.

(v) The Branch also maintains close contact with provincial forest research divisions in those provinces that conduct forest research, principally Ontario and British Columbia. The provincial research organizations deal primarily with problems related intimately to the administrative and management responsibilities of their respective departments. Collaboration of the Forestry Branch with the provincial research divisions is arranged formally through regional advisory committees and through subsequent work conferences and consultations involving managerial and research staff of the co-operating organizations, to work out project details and collaborative arrangements and to avoid gaps and overlap in programs.

2. Canadian Standards Association: Many officers of the Department assist the Canadian Standards Association by providing technical information that will result in sound standards. The Forest Products Laboratories do research to establish limiting conditions and to develop test programs for wood and wood products.

2.2 (d) Review of the forestry program with respect to operational effectiveness takes place at several levels: within each establishment, between adjacent regional establishments when a project has broad geographical significance, and between Institutes and regional establishments when there is need for input into a regional program from a special field of research covered specifically by an Institute. Finally, there is a review of all major problem areas by headquarters staff.

2. To provide for adequate appraisal of the program, specific committees and structures have been established. Directors of regional establishments are assisted in making comprehensive assessments of research needs and priorities by Regional Advisory Committees on Forestry Research. The essential points in the Terms of Reference for these Committees are:

(a) To provide advice to the regional director.

(b) To establish criteria for evaluating major forestry problems of the region, to the solution of which the Forestry Branch may contribute.

(c) To review problems brought forward by their own membership and also through other channels, with the purpose of defining them in specific terms and advising on priorities.

(d) To advise on establishment of broad programs and required resources, and to review progress.

(e) To advise on coordination of Forestry Branch programs and those undertaken by other agencies.

(f) Membership is to consist of representatives of the provincial forest service(s), other appropriate governmental or regional agencies, associations of the forest industries, universities, and the Forestry Branch.

3. The Directors of the two Forest Products Laboratories are assisted by Research Program Committees that operate at the technical level, with their primary function being to review existing programs as to their technical and economic significance,

and to recommend initiation of new projects as seen necessary. These Committees also relay to the Laboratories information on industrial developments that may influence program planning in forest products research. Membership of the Committee is drawn from the wood-using industries relevant to the particular subject-matter content of the respective Committees, which are identified as follows:

Ottawa Laboratory

1. Lumber
2. Plywood
3. Wood Preservation
4. Furniture

Vancouver Laboratory

1. Timber Engineering
2. Lumber
3. Plywood

4. There is also a National Advisory Committee on Forest Products, which is comprised of seven senior executives of the forest products industries. Each member is the nominee of an association representing a field of interest corresponding to one of the seven Research Program Committees. The National Advisory Committee is advisory to the Deputy Minister on policy matters, such as points of emphasis in forest products research, industry trends, and significance of research needs in selected fields. It has been particularly concerned with the development of economic criteria needed for appraisal of research project proposals, namely, objective assessment of potential output from the proposed research as well as required input in research personnel, funds, facilities, and duration of the project. It has also been concerned with the communication of research results to the user industries.

5. Internally, each research unit of the Forestry Branch has a group of research managers that review the total program of the unit. There is also at headquarters a group of Program

Coordinators that is constantly reviewing and revising programs that are widespread geographically or require the involvement of scientists from a wide range of research disciplines.

6. The Forestry Branch Program Committee meets twice annually to review the total program with respect to progress, priorities, and needs for personnel and funds. This Committee is chaired by the Assistant Deputy Minister of Forestry and its membership is made up of all the Directors of research units and the Program Coordinators. Directors of the Department's Personnel, Financial, and Information Services attend as observers and advisers. It reports to the Deputy Minister, who reviews the forestry research program in relation to the total program and obligations of the Department.

7. In addition to the provision for formal review described above, there is a direct involvement of research staff in general with their professional counterparts in provincial forestry services, industrial organizations, and other research and development agencies, toward the development or refinement of methods, procedures, biological materials, or equipment that have an immediate or potential role in operational practice. Examples of the subject matter covered in such involvement are given in Appendix 2.2 (d).

8. To recapitulate briefly, the forestry program is revised and modified under the influence of a multiplicity of forces and factors, including direct requests and suggestions from provincial departments and industry at the laboratory level and from national associations or like bodies at the headquarters level; proposals advanced by Advisory Committees which in turn represent the provincial departments, industrial associations, universities, and other regional agencies; information feed-back and results of collaborative projects involving liaison and development personnel and research staff of the Forestry Branch and their counterparts in the provincial services and the industry; requests for forestry services from other federal departments; proposals advanced by Branch research staff as a result of "break-throughs" in their

own projects; and by directives from Branch and Departmental management to ensure fulfillment of obligations falling on the Department.

9. From this wide assortment of advice, suggestions and requests and directives for work to be undertaken, it is necessary for each establishment director to develop an integrated and coherent program of work that is appropriately responsive to demonstrated need, that provides real challenge to the staff, and that lies within the designated field of work assigned to the particular establishment of the Forestry Branch.

2.2 (e) During the last five years, two studies have been conducted to suggest improvements in operating procedures of federal forestry.

(i) In 1963, the Civil Service Commission was requested by the Deputy Minister of Forestry to examine the organization of the Department of Forestry, recognizing the necessity of an integrated departmental program with a headquarters organization based on the principle of program integration and unified management of field activities on a regional basis; and to recommend any changes that would improve the department's ability to achieve its objectives.

This study was carried out in 1963 and, as a consequence, the forestry program at Head Office and in the Regions was reorganized to its present form, effective April 1st, 1965.

(ii) In 1966, Woods, Gordon and Co., Management Consultants, entered into a contract to do an organization and staffing study of field establishments of the Forestry Branch with the following objectives:

(a) To identify and assess administrative support requirements for field establishments in the functional areas of personnel, financial, materiel and office services on the basis of the existing forestry program and in the context of the Plan for Development of Forest Research and Related Activities, 1965-1971;

(b) To develop an organizational concept for an average sized regional establishment;

(c) To develop organization and staff plans for selected field establishments.

The contractors on completion of their study recommended a structure to deal with administration in regional offices of different sizes, and the Branch moved immediately to make changes necessary to adopt the recommendations. The reorganization is nearly complete.

2.2 (f) The activities carried out within a federal forestry research program must be properly supported by enabling legislation. The BNA Act assigned exclusive rights to the provinces for the management and sale of public lands, including the timber and wood thereon. In addition, the provinces have been given exclusive authority over property and civil rights, municipal affairs, local works and undertakings, and matters of a merely local or private nature. Excluded from the section referring to local works and undertakings are such works as are declared by the Parliament of Canada to be for the general advantage of Canada or for the advantage of two or more provinces.

2. Management and administration of federal crown lands, on the other hand, are the responsibility of the federal government. These lands include the Yukon and Northwest Territories, as well as certain lands within provincial boundaries, such as national parks, Indian lands, and Canadian Armed Forces bases.

3. The Parliament of Canada has been given exclusive responsibility for a number of matters which, because of the broad nature of the forest industries, do have an effect on the operation of the forestry sector and implications for forest policy. These matters include the regulation of trade and commerce, taxation, and international and interprovincial transport.

4. The field of forestry in its broadest sense has a very wide range of activities. At one end of the scale are all those activities required for the administration of forestlands and the forest resources on crown lands -- surveys, allocation of resources, establishment of rules and regulations, the collection of fees and charges, and the supervision of operations. These functions are clearly the responsibilities of provincial governments. The harvesting, manufacturing, and sale of forest products are the responsibility of the private sector. Responsibilities for protecting, renewing, and improving the resource vary from province to province -- provincial governments, land owners, lessees, and the federal government are all directly involved in these activities. Matters having to

do with policies in the field of trade and commerce in general, many of which have important implications for the operation of the forestry sector, are the responsibility of the federal government but provincial governments are also active in this field. Education of professional foresters is carried out by the universities. Private associations, industries, provincial governments and the federal government are all involved in public education.

5. The federal government is inevitably involved indirectly with the forestry sector through its activities which apply across the economic spectrum. It has in addition, however, a direct concern in forestry for two fundamental reasons -- (a) the responsibility of the federal government for economic growth and high-level performance of the economy, and (b) the key role that forestry and the forest industries play in the Canadian economy.

6. Of the many different activities carried out in forestry by government and private agencies, the federal government has responsibility in a large number. The following list indicates the range of the functions carried out together with comments on agency participation:

(a) Forest resource surveys and inventories -- Carried out by provincial departments responsible for forestry. Information is used by provincial governments, federal government departments, and industry.

(b) Statistics and economic information -- Collected primarily by the Dominion Bureau of Statistics with some input by provincial governments and private agencies. Widely used.

(c) Administration of crown forests -- Allocation of limits, rules and regulations, establishment of practices, fees. Carried out by provincial forestry departments. Of interest to other provincial departments, industry and federal government departments.

(d) Fire protection -- Ultimate responsibility is with provincial forestry departments. Industry and land owners are closely involved, sometimes jointly. Various federal departments

and industry provide inputs via the development of equipment.

(e) Protection against pests -- Responsibility for control action rests with provincial departments and industry; the federal government is closely involved in pest surveys, hazard assessment, and consultative services, and in the case of biological control projects, provides the control agents (parasites, predators, pathogens).

(f) Provision of infrastructure, roads, etc. -- The provincial government forestry departments and departments of highways are mainly responsible. The federal government is involved in some areas, for instance, in regional development.

(g) Harvesting -- Carried out by private sector under rules and regulations established by provincial forestry departments.

(h) Manufacturing -- Carried out by private sector.

(i) Investment in the resource -- Forest renewal, forest improvement, and forest extension are the responsibility of provincial governments, industry, and private land owners. Agencies concerned with regional development provide some inputs. This function is of general interest to the economy.

(j) Research and development.

 (i) Forest research -- Mainly provided for by Forestry Branch. Function also performed in part by forestry departments in several provinces and by industry. Inputs also provided by a number of other research agencies.

 (ii) Products research -- Mainly by private industry in the pulp and paper sector, and by Forestry Branch in other products. Some input by other research agencies.

 (iii) Product development -- Responsibility of private sector. Some input by various government agencies.

(k) Advisory services and liaison -- Responsibilities are not clearly defined. The Forestry Branch, provincial governments, and companies, are all involved, with some support from regional development agencies and universities.

(i) Public education -- Provincial forestry departments, the Forestry Branch, individual companies and associations all contribute to this function. Other agencies provide some input.

7. It is considered appropriate that the functions of the Forestry Branch should be those which conform to one or more of the following criteria:

(a) Those functions required to meet the needs of the federal government which are not a logical part of other federal programs.

(b) Those functions which can most efficiently be carried out on a national basis.

(c) Those functions which would not otherwise be done because the returns to any other agency would not justify the effort required.

8. Under the provisions of the Forestry Development and Research Act (para. 2.2(a)) and on the basis of the three criteria listed above, appropriate roles for the Forestry Branch are as follows:

(a) The carrying out of a broad-scale, comprehensive research program.

(b) Coordination of or in special cases carrying out of surveys.

(c) Provision of advisory and liaison services to provincial forestry departments, forest and woodlot owners, forest operators, and to the manufacturing sector.

(d) A public education program complementary with programs of other agencies.

(e) Financial support for certain programs which are in the national interest but which cannot be financed by provincial or private agencies.

(f) Representation of forestry interests in international affairs in cooperation with other responsible federal and provincial departments. Participation in the forestry programs of the External Aid Program is included here.

(g) The management of forests on federal lands.

(h) Coordination and synchronization of forestry activities of various federal agencies.

(i) Representation of forestry interests in broad government programs having to do with such things as trade policy, taxation, and finance, science policy, space program, etc.

2.2 (g) Effective forestry research requires the development of an integrated program wherein efforts in a considerable number of scientific disciplines can be directed and coordinated toward the solution of problems existing in varied ecological and economic conditions over wide areas. A successful program cannot be built up from a number of ad hoc projects initiated independently and without reference to other projects or problem areas of broad regional or national significance.

2. An effective forest research program must be planned on the basis that certain numbers of personnel with specific training will be available at appropriate stages in the development based on established program priorities, and that adequate operating funds and capital facilities will be provided as required.

3. The major hindrance to the development of an optimum forest research program in the Forestry Branch results from the fact that the federal government has not yet developed a policy that assures the development and implementation of long-term plans. There is no assurance that funds and personnel will be available to permit the orderly and progressive development of programs that entail long-range planning. Owing to this, recruiting is seriously handicapped because universities, technology institutes and vocational schools cannot plan training schedules to provide the various types of recruits when they are needed.

4. A major handicap to the implementation of research results in practical operations of the provincial forestry departments and the wood-using industries is the shortage of personnel and funds needed for pilot-scale operational projects and demonstrations of the potential practical usefulness of these results. The termination on March 31st, 1967 of the Composite Forestry Agreements with

the provinces eliminated an important federal inducement to the provinces to increase their knowledge of the forest resources and to improve forest management practices. Termination of the Composite Agreements and consequent reluctance to enter into new special forestry agreements with provinces for particular objectives seem likely to impede implementation of research results arising from the Forestry Branch program.

2.2 (h) The Forestry Branch, as presently organized, was developed at April 1st, 1965, by bringing together staff from other Branches in the Department of Forestry, later the Department of Forestry and Rural Development. By Order-in-Council No. P. C. 1968-1299, dated July 12th, 1968, the Forestry Branch was transferred to the Department of Fisheries, along with other elements of the Department of Forestry and Rural Development that provide advisory, administrative and technical support for the forestry program. Most of the support groups are being merged with comparable groups in the Department of Fisheries to serve the needs of the enlarged Department of Fisheries and Forestry (e.g. Library, Engineering Services, administration and personnel service divisions), and others will provide the nucleus for enlarged groups in the new Department (e.g. Biometrics Research Service, and Art and Photo Unit of the Information Service).

2. Apart from strengthening the headquarters structure to provide for more effective operational planning and more formal attention to continually increasing functions associated with external relations in technical and scientific fields, it is not expected that major organization changes or functions will be necessary in the next five years. One development that is anticipated is the bringing together of four institutes (Forest Fire Research, Forest Management, Chemical Control, and Ecology Research) in the Forest Research Centre, being planned for establishment in the area west of Hull, Quebec.

2.3 Personnel Policies

2.3 (a) University graduates for the Forestry Branch have been identified and hired through the following media:

(i) Formal Recruiting Programs at Canadian and American Universities.

(ii) Visits of recruiting teams to the United Kingdom - England, Ireland and Scotland - and to European countries including France, Belgium, Germany, Holland, etc.

(iii) Personal correspondence with candidates listed with the American Institute of Biological Sciences Placement Service.

(iv) Contacts established with university professors who are well known to the Branch and who are supervising graduate students.

(v) Enquiries made by Branch scientists who attend scientific meetings and symposia.

(vi) Summer employment programs involving 300-400 under-graduate and graduate students.

(vii) Effective utilization of N.R.C. - D.B.S. and Department of Labour directories of Canadians studying in the U.S. and United Kingdom. Close liaison with the Department of Manpower & Immigration's "Operations Retrieval Program".

(b) Criteria employed to forecast creativity and to assist in the identification of effective researchers:

It must be stated that creativity and aptitude are perhaps intangible factors to identify readily in the new graduate. It has been our experience that certain characteristics are associated with individuals who possess these qualities. We therefore examine the following points very carefully with the expectation that they will act as indicators in identifying research aptitude and creativity:

(i) The student's academic achievement in subjects directly associated with the proposed employment.

(ii) Reliable comments from academic staff (e.g. professors, laboratory supervisors, guidance counsellors, etc.) re the student's performance in the classroom, laboratory and on field assignments.

(iii) Through discreet questions raised during a personal interview which determine the individual's intellectual ability, deductive processes and his general acuity.

(iv) Where possible, through careful evaluation of appraisal reports from supervisors under whose direction the student worked during summer months.

(c) Identification of staff with high potentiality as research administrators:

There is considerable truth in the axiom that "all competent researchers do not make good administrators". It is therefore imperative to identify leadership qualities in the persons who may become future research administrators. Through various assignments these characteristics are quickly identified. A number of individuals have been assigned responsibilities as Section Heads, Acting Coordinators, Task Force Leaders, Members of various committees, etc. In these roles they display their administrative talents in supervising staff, in resolving difficult personnel matters, by successfully achieving project objectives and finally by the effective utilization of men, money and materials.

(d) Distinction between administrators of research and researchers as such:

Personnel performing duties of a research administrative nature are usually classified in the Research Management series. There are three levels within this category. Each has a minimum and maximum salary, a mid-point and a number of defined incremental steps. Individuals are promoted in accordance with responsibilities, class standards and performance.

2. In contrast to Research Managers, those performing research "per se" are classified as Research Officers or Research Scientists.

3. The former category includes bachelor or master graduates with varying degrees of experience. There are five levels, each having a specific series of incremental steps.

4. Researchers classified as Research Scientists must possess a doctorate degree or have a bachelor degree and five years of highly productive related experience. There are four separate levels with the minimum salary at the initial level being $10,200. Unlike the Research Officer series the Research Scientist ranges have no incremental steps. In fact, the Research Scientist 4 has no maximum salary.

5. Each employee in the Research Scientist series is appraised annually. Recommendations on salary increases and/or promotions are initiated by respective Regional Directors. Promotions are based on research productivity. All recommendations are reviewed by a Departmental Committee and subsequently by an Interdepartmental Appraisal Board.

(e) Policy regarding intramural and extramural education for staff members conducting research:

The expansion of research programs in the Forestry Branch over the last three years has created an unprecedented demand for research personnel with advanced academic training. Technological advances have placed a heavy responsibility on universities to train specialists, in sufficient numbers, to meet market demands. Recruitment programs alone do not meet total needs. A substantial number of bachelor and master graduates have been recruited in the expectation that higher academic qualifications for research will be acquired through advanced training. Towards this objective the Branch administers an Educational Leave Program to provide such training. This is classified as Outservice Training and is governed by Treasury Board policy on post-graduate education.

2. To justify the expenditure of public funds for the subsidization of an employee's post-graduate training, the following conditions must be met:

(i) The proposed course of study must be related to an identifiable need arising out of Forestry Branch programs.

(ii) Individuals selected for post-graduate training must provide evidence of high academic achievement.

(iii) The Forestry Branch, as a responsible manager, must be able to demonstrate that the training will increase the employee's usefulness and productivity.

With few exceptions those sent on post-graduate training receive an allowance equivalent to half salary plus the payment of their tuition and travel to and from the university center concerned.

3. In addition to this type of extramural education, the Branch does encourage as many employees as possible to improve their academic qualifications by taking individual courses which are directly related to the individual's work. Those taking such courses and expecting to receive financial assistance must receive prior approval. If an individual successfully completes these courses he is reimbursed by the government to the extent of fifty per cent of the cost involved.

2.4 Distribution of Activities

2.4 (a) Records of expenditures on scientific activities by the Forestry Branch are kept separate by reporting units, but not by provinces. Section 2.6 (b) records the distribution of expenditures by units within the Branch. Expenditures by regional establishments are made almost entirely within their boundaries. When two or more provinces form a region, that province containing the regional office would receive the greater proportion of the total expenditure. The pattern for Institutes varies but, generally speaking, expenditures by the Vancouver Forest Products Laboratory are made in British Columbia, and those for the Ottawa Forest Products Laboratory in the other provinces, mainly east of Manitoba and most heavily concentrated in the vicinity of Ottawa. Expenditures by the Petawawa Forest Experiment Station and the Insect Pathology Research Institute are centered in Ontario, as are those for the other Institutes which are located in Ottawa. However, much of the field work carried out by Institutes is distributed throughout Canada. Expenditures by Headquarters, except for travel, are concentrated in and near Ottawa.

2.4 (b) Because of climatic and geographical variations and political divisions in Canada, forestry problems are not often country-wide in nature and it has been found more effective to direct research investigations from regional bases rather than from a centralized unit. To this end, the Forestry Branch has established seven regional laboratories, each of which is capable of dealing with the major forestry problems of its region. The two Forest Products Laboratories are responsible for research relating to conversion of forest products into marketable commodities, and there are a number of Institutes that deal in depth in certain specialized fields to support programs in the regional laboratories.

2. The regions are not all faced with the same problems, and activities in certain fields are more properly carried out by the Branch in some regions than in others. One of the important reasons is the variation in provincial forestry legislation and organization. Some provinces have established their own research programs in silviculture and in certain phases of tree biology, and the Forestry Branch program in those provinces is developed to complement or supplement them. Most provinces have no research programs and are dependent on the federal authority for all forest research done.

3. The type of research program in a region is dictated also to a considerable degree by the contribution of the forests to the regional economy and by the number of important stand types or tree mixtures, which is dependent on topographical and climatic conditions.

4. In forest protection, certain problems are predominantly of regional importance because of restricted distribution of introduced pests. This is especially true of the east coast and, to a limited extent, also of southwestern British Columbia. A similar situation also occurs in southern Ontario and southern Quebec because of secondary introductions from the United States. Fire research problems vary in the different regions of Canada depending

upon the nature and amount of fuel available and the climatic conditions prevalent.

5. Economically significant problems that are regionally-oriented include:

(a) Chemical control of the spruce budworm in New Brunswick.

(b) Diseases and insect pests in coniferous plantations in Ontario.

(c) Reforestation of abandoned farmlands in eastern Canada.

(d) Afforestation of large barrens in Newfoundland.

(e) Development of mechanized harvesting systems in the boreal forests of Quebec and Ontario.

(f) Watershed research in the foothills of Alberta.

(g) Protection against cone insects in the seed orchards of British Columbia.

(h) Studies of shelterbelts in the prairie provinces.

(i) Studies of western timber species in the Vancouver Forest Products Laboratory.

2.4 (c) Scientific activities carried out annually by the regional forestry establishments and the forest products laboratories of the Forestry Branch, to assist in the investigation of regional problems and phenomena, are directed toward the solution of practical problems. The research done in the Institutes tends to be more fundamental in nature but here also individual scientists may form part of a regional team working towards solution of a specific regional problem. These scientific activities can be classified as (1) research, (2) research development, (3) data collection, (4) scientific information, and (5) education.

Research

2. Applied research predominates and is performed in land classification, soils, mensuration, silviculture, wood engineering, photogrammetry, genetics and tree improvement, fire, entomology, pathology, wood properties, harvesting and processing, and forest economics.

3. Fundamental research is performed in soils, ecology, hydrology, physiology, fire, physics, chemistry, entomology, and pathology.

Research Development

4. Developmental research is an expanding activity, but presently lags behind research and data collecting activities. Programs in the form of trials and demonstration are conducted in land classification, relationships between forests and soils, fertilization, survey and measurement, inventory and volume regulation, silvicultural methods, water production and regulation, tree improvement and provenance testing, fire danger forecasting, fire protection and fire use, insect and disease detection, biological and chemical control of insects and diseases, appraisal of control methods, wood utilization, processing and harvesting.

Data Collection

5. Data collection is an indispensible prelude to research and developmental programs. It includes surveys, mapping and the systematic gathering and arrangement of data of land systems in terms of productivity, accessibility and sustained yield capacity, of growth and yield characteristics of tree species, of water yield and water loss, of fire hazard and loss, of insect and disease hazard and loss, of forest resources, production, utilization and marketing of forest products.

Scientific Information

6. The dissemination of scientific and technological information is accomplished through several means. The chief ways are:

(a) The publication of information on research and surveys in scientific, technical and semi-technical journals and, also, in one of several forms of in-house publications that are aimed at selected audiences or the general public.

(b) Audio-visual displays of activities being performed.

(c) The occurrence in each region of an information service to foster an informed public attitude on forestry generally and on objectives of the Forestry Branch in particular.

Education

7. Members of the Branch provide lectures and short courses at universities, forestry technology schools, and at in-service schools of provincial forestry and national parks organizations. Also, several members of the Branch are concerned with directing at least part of the training program of graduate students in universities. Funds are spent on extramural research programs at universities, which commonly form part of the training program of graduate students. Also, the operational grants to the four forestry schools provide assistance in developing the graduate training programs there.

2.4 (d) The Forestry Branch contributes to regional development by providing a better understanding of the regional forest estate and by recommending improvements in programs for management, protection and utilization of the forest resource. To obtain the above aim, the objectives of the Forestry Branch are:

(a) Through consultative processes with other forestry agencies, and with close attention to economic implications, to identify and delineate forestry problems and establish research priorities for their solution.

(b) Through multidisciplinary research, to elucidate the natural phenomena governing forest productivity and to identify and render amenable to amelioration the factors that limit productivity.

(c) Through research and surveys, to develop and demonstrate productivity-sensitive land classification systems that will permit judicious distinctions between forested lands having different productive capacities.

(d) In liaison with other research agencies and through development and demonstration of methods for minimizing the impairment of forest values by fire, pests and other causes, to provide practical means for improving forest productivity generally, with priority of attention in areas most suited to wood production to the securing of forest regeneration.

(e) Through economic studies, to provide governments and industries with information that is basic to the establishing of policies and enactment of legislation pertaining to land use, forest protection, production and marketing.

(f) By publication of research findings to assure dissemination of information necessary for optimal use of forest resources and through a public information program incorporating a multiple use concept of resource management, to promote public regard for the forest estate and for the agency aims, objectives and programs.

2.4 (e) The research program of the Forestry Branch is largely decentralized and a great amount of it has been carried out from regional laboratories for many years.

2. Because of decentralization there are probably extra administrative costs but these are no doubt offset by the decrease in amount of travel that would be required if all the research staff were located in one central area and had to travel from there to all the regions and back annually or more often.

3. Decentralization of the forestry research program provides many benefits. By locating the research staff in a region, they become familiar with the problems of that region and are able to develop a full appreciation of the priority of their significance to forestry before commitments and plans are made to embark on research. This can be gained only through contact and frequent discussion with appropriate personnel from provincial governments, universities, and industry. Scientists by being located permanently in a region become familiar with the forest management practices there and also, they can much more easily apply the results of their research at the most appropriate season rather than when scientists from a centralized organization might be able to be in the region.

4. Through frequent contacts with a wide range of personnel in a region, scientists are able to recognize industry-wide problems that are not necessarily paramount in one company, but which in the aggregate represent a substantial problem that requires attention. Finally, it can be stated that variation in the approaches to problems between different regions stimulates scientific efforts.

5. The critical conditions which must be observed to ensure that regional distribution of effort contributes to regional development are:

- To maintain a critical mass of scientific effort in terms of both numbers of scientists and variety of specializations.
- To achieve coordination in both the planning and the conduct of research on an inter-regional basis.

- To make adequate provision for the development, testing and demonstration of the solutions of problems at the regional level.

2.5 Personnel Associated with Scientific Activities

Information of the nature requested on personnel associated with scientific forestry activities is not kept separate for each unit but only on a Branch basis. The most recent data on total personnel in the Branch are dated July 31, 1968, but data on professional personnel in Sections 2.5(b) and 2.5(c) are as of September 30, 1968. This accounts for differences in numbers of professional personnel in different Tables in this Section.

2.5 (a) The personnel establishment of the Forestry Branch assigned to scientific activities and the number on strength July 31, 1968, were as follows:

	Personnel Assigned to Scientific Activities		Strength July 31, 1968
	Approved for 1968-69	Limit imposed by T.B. letter of March 7, 1968	
Professionals	627	580	534
Technicians	772	690	675
Workers	65	65	65
Other supporting personnel	351	304	320*
Total -	1815	1639	1594

*Includes casuals in continuing positions

Post-doctorate fellows - 6 (not included above)

2.5(b) Of 542 professional personnel in the Branch on September 30, 1968, 49 (9%) devote all or most of their time to the administration of scientific activities.

2.5 (c) Detailed information respecting the professional staff associated with scientific activities in forestry is given in the Appendices. Appendix 2.5)c)i. shows that 133 bachelors, 182 masters and 227 doctors were born in 45 countries; 57.5% were born in Canada. In Appendix 2.5)c)ii, it is shown that these professional personnel received their elementary education in 43 countries; 61% of them in Canada. The 26 countries in

which these professional personnel obtained their highest university degree are listed in Appendix 2.5)c)iii. Canadian universities graduated 53% of the total of 542. Appendix 2.5)c)iv provides information on how long all bachelors, masters and doctors have worked since graduation and how long they have been in the Forestry Branch.

2.5(c)(v) The average age of professional personnel in the Forestry Branch is for bachelors 41 years (range 22 to 64), for masters 37 years (range 24 to 62), and for doctors 39 years (range 26 to 70). The average age of all is 39 years.

2.5(c)(vi) The proportion of the number of professional scientists in the Forestry Branch who can operate effectively in Canada's two official languages is given in the following table (page 41).

2.5 (d) The numbers of professional staff in each degree category since 1965 were as tabulated below. Records are not available prior to reorganization of the Forestry Branch, April 1, 1965.

	Bachelor	Master	Doctor	Total
1965-66	87	120	139	346
1966-67	90	139	193	422
1967-68	117	178	225	520
1968 - at Sept. 30	133	182	227	542

2.5 (e) During the last three fiscal years, the professional staff has been enlarged because of a major development in the forest research program, but, at the same time, there has been a considerable number of resignations. These data, shown below, are not available by degree levels.

	Numbers of Professional Staff		
Fiscal Year	At beginning of year	Appointments during year	Separations during year
1965-66	346	95	19
1966-67	422	127	29
1967-68	520	50	20

LANGUAGE PROFICIENCY

	Degree Level, Numbers and Percentage			
	Bachelor	Master	Doctor	Total
Speak, read and write English and French	22 (16.5)	22 (12.1)	33 (14.5)	77 (14.2)
Speak, read and write English				
and Read French	40 (30.0)	59 (32.4)	103 (45.3)	202 (37.2)
Write and read French	7 (5.3)	7 (3.9)	7 (3.0)	21 (3.9)
Speak French	1 (0.8)	1 (0.5)	-	2 (0.4)
Speak and read French	5 (3.8)	5 (2.8)	7 (3.4)	17 (3.1)
Have no capability in French	57 (42.8)	85 (46.8)	76 (33.4)	218 (40.2)
Speak, read and write French				
and Read English	-	1 (0.5)	-	1 (0.2)
Write and read English	-	1 (0.5)	1 (0.4)	2 (0.4)
Speak and read English	1 (0.8)	1 (0.5)	-	2 (0.4)
Total	133 (100%)	182 (100%)	227 (100%)	542 (100%)

2.5 (f) The percentages of current professional personnel who have been employed, since graduation, in given sectors are tabulated below. These data cannot be added because individuals may appear in more than one category.

Sector	Doctorate Level	Master Level	Bachelor Level	All
Industry	17	23	32	23
University	38	16	7	23
Provincial Departments	8	17	20	14
Other Federal Agencies	11	12	18	13
Foreign Governments	18	14	7	14

2.5 (g) Those on educational leave in 1968-69 are (present level) bachelors - 20; masters - 26; doctors - 0.

2.5 (h) Numbers of university students given seasonal employment were 317 in 1965-66, 335 in 1966-67, and 340 in 1967-68.

2.6 Expenditures associated with scientific activities

2.6 (a) The Forestry Branch was established April 1, 1965 and data on financial expenditures by the component parts of the Branch are not available for earlier periods. The total expenditures on scientific activities during three fiscal years, 1965-66 to 1967-68, and the estimate for 1968-69, are given below, broken down according to (a) functions, (b) disciplines, and (c) areas of application.

	Expenditures (Thousands of dollars)			
	Actual			Estimated
	1965-66	1966-67	1967-68	1968-69
(i) Functions				
Intramural R. and D.	7,197	9,633	12,904	14,535
Data Collection	3,271	4,379	5,866	6,607
Scientific Information	436	584	782	881
Support of R. and D. in Industry	1,382	749	252	-
Support of R. and D. in Universities	66	84	179	201
Support of Higher Education in Engineering and Science	-	-	160	160
	12,352	15,429	20,143	22,384
(ii) Scientific Disciplines				
Engineering and Technology	864	1,080	1,410	1,567
Natural Sciences:				
Agricultural Sciences (forestry)	8,029	10,029	13,093	14,550
Biological Sciences	2,470	3,086	4,029	4,477
Chemistry	618	771	1,007	1,119
Physics	371	463	604	671
	12,352	15,429	20,143	22,384
(iii) Areas of Application				
Agriculture (forestry)	10,970	14,680	19,891	22,384
Industry*	1,382	749	252	-
	12,352	15,429	20,143	22,384

*These funds were provided in support of the Pulp and Paper Research Institute of Canada

2.6 (b) Operating and capital funds expended by each of the main units of the Forestry Branch are given below for the last four fiscal years:

	Expenditures (Thousands of dollars)			
	Actual			Estimated
Units	1965-66	1966-67	1967-68	1968-69
Regional Establishments				
Newfoundland	314	461	633	748
Maritimes	1,327	1,581	1,975	2,357
Quebec	729	1,305	1,624	1,575
Ontario	1,348	1,442	1,642	2,036
Manitoba-Saskatchewan	711	971	1,203	1,366
Alberta-NWT-Yukon	689	1,117	1,806	2,439
British Columbia	1,340	1,428	1,765	2,246
Institutes				
Ottawa Forest Products Laboratory	601	1,175	1,551	1,686
Vancouver Forest Products Laboratory	684	1,065	1,455	1,840
Petawawa Forest Experiment Station	1,124	1,430	1,661	1,425
Insect Pathology Research	326	756	756	694
Forest Management	166	594	1,249	736
Forest Fire	126	194	220	251
Forest Economics	42	80	195	481
Chemical Control	88	90	218	321
Forestry Branch Headquarters*	1,355	991	1,938	2,183
Total Forestry Branch	10,970	14,680	19,891	22,384

*Includes extensive outlays on behalf of other Branch units in connection with publications, removal expenses, library services, computing services, etc. but not those in support of the Pulp and Paper Research Institute of Canada shown in Section 2.6 (a)

2.6 (c) Funds expended by Forestry Branch since its formation April 1, 1965 to further professional education of staff are shown below. The Branch did not assist with tuition fees and travel or removal expenses before 1966-67, but grants equivalent to half-pay have been made for many years for those on educational leave.

	Expenditures (Dollars)			
		Actual		Estimated
	1965-66	1966-67	1967-68	1968-69
(i) Staff on educational leave				
Allowance equivalent to 1/2 pay	39,951	66,601	90,359	143,818
Tuition fees		12,069	9,713	28,029
Travel and removal expenses		2,090	26,689	12,066
	39,951	80,760	126,761	183,913
(ii) Tuition fees of staff not on educational leave (generally 50% of the fees is paid by the staff member)		200	900	1,200
	39,951	80,960	127,661	185,113

2.7 Research Policies

2.7)a)1) Numerous factors influence the development of the forestry program. It has been traditional for executives of the provincial forestry departments and the forest-based industries to propose to directors of Branch research establishments that work be undertaken on certain projects of particular concern, and for representatives of national associations and committees to make representation to senior officers regarding increased emphasis in broad problem areas. Proposals for program development and particular projects arise inevitably and continually from our own professional staff. All such sources of suggestions have proved valuable to us and will continue to introduce new proposals and concepts.

2. The reorganization of the Branch in 1965, the increased authority of establishment directors resulting therefrom, and the forecast in 1965-66 of greatly expanded research establishments expected in following years increased the need for senior officers and establishment directors to have more comprehensive assessments of research needs and priorities from the varied segments of the forest community. Steps were taken in 1966 to meet these needs through the establishment of advisory committees on forest research in the seven regions. With reference to forest products research, a national advisory committee was established and a series of research program committees was set up in specialized subject-matter fields.

Regional Advisory Committees

3. Essential points of the terms of reference for the regional advisory committees are:

(a) To provide advice to the regional director.

(b) To establish criteria for evaluating major forestry problems of the region, to the solution of which the Forestry Branch may contribute.

(c) To review problems brought forward by their own membership and also through other channels, with the purpose of defining them in specific terms and advising on priorities.

(d) To advise on establishment of broad programs and required resources, and to review progress.

(e) To advise on coordination of Forestry Branch programs and those undertaken by other agencies.

(f) Membership is to consist of representatives of the provincial forest service(s), other appropriate governmental or regional agencies, associations of the forest industries, universities, and the Forestry Branch.

4. Advisory committees have been active in most regions, and they have provided valuable advice and guidance in the appraisal of broad problem areas and priorities that reflect the real research needs of the provincial departments and the industry.

Research Program Committees (Forest Products)

5. Research program committees in the forest products field operate at the technical level, with their primary functions being to review existing programs at the two forest products laboratories as to their technical and economic significance, and to recommend initiation of work on new projects for which essential background information will have been provided. The committees are also expected to keep the laboratories informed on industrial developments that may influence program planning in forest products research. Membership of each committee is drawn from the wood-using industries relevant to the particular subject-matter it covers.

6. These committees are advisory to the directors of the respective laboratories. They have produced useful results in those instances where the industries are well organized within

industry associations and are able to nominate technical representation to the committees. This applies to the three western committees and to two of the four eastern committees.

National Advisory Committee (Forest Products)

7. The National Advisory Committee on Forest Products is comprised of seven senior executives of the forest products industries, each person being the nominee of an association representing a field of interest corresponding to one of the seven research program committees. The National Advisory Committee is advisory to the Deputy Minister on policy matters, such as points of emphasis in forest products research, industry trends and significance of research needs in selected fields. The committee has met three times since its establishment in the spring of 1967 and has been particularly concerned with the development of economic criteria needed for appraisal of research project proposals, namely, objective assessment of potential output from the proposed research as well as required input in research personnel funds, facilities and duration of the project. It has also been concerned with the communication of research results to the user industries.

8. Another factor influencing program development is the increased direct "feed-back" of information and suggestions from provincial departments, industry and other agencies, that has been promoted by the creation, or enlargement, of the liaison development and service activity within Branch establishments during the past three years. Members of these functional groups have also promoted cooperative developmental projects with provincial departments, industry and other agencies to ensure more rapid transfer of research findings into operational practice.

9. To recapitulate briefly, the selection and initiation of program and projects are influenced by a multiplicity of forces and factors, including direct requests and suggestions from provincial departments and industry at the laboratory level and from national associations or like bodies at the headquarters level;

proposals advanced by advisory committees which in turn represent the provincial departments, industrial associations, universities and other regional agencies; information feed-back and results of collaborative projects involving liaison and development personnel and research staff of the Forestry Branch and their counterparts in the provincial services and the industry; requests for forestry services from other federal departments; proposals advanced by Branch research staff as a result of "break-throughs" in their own projects; and by directives from Branch and Departmental management to ensure fulfillment of obligations falling on the Department.

2.7)a)2

Planning and priorities within major areas of the forestry program are undertaken at the national level by the Directorate of Program Coordination and regionally by the directors of Branch establishments. Within the regional establishment the director works in close collaboration with his senior associates which include the associate director, section leaders and task force heads. In establishing priorities for programs at both the national and regional levels the Branch is guided by a number of specific considerations including the following:

(a) Degree of urgency of the problem, e.g., importance of immediate action in effecting control, reducing losses, or providing support to a segment of industry in a state of ill health due to lack of technical data.

(b) Extent and duration of the benefits that may be derived from Branch participation, e.g., support of national codes and specifications affecting the forest industry in general, and serving the long-term national interests through improved knowledge of the resource, its renewal, protection, development and utilization.

(c) The possibility that work in progress by other research organizations will meet the needs, or that pooling of

resources with another research organization may be a more effective and economical method of meeting needs.

(d) The availability of competent staff and required facilities, or the prospect of acquiring them in reasonable time, or alternatively, the possibility of having essential work done under a research or professional service contract.

(e) Through the development of cost/benefit analysis of proposed programs, which though presently in very preliminary stages, is expected to advance considerably in the next few years.

2.7)a)3 Network methods such as CPN or PERT are not used to plan and monitor programmes but program evaluation does take place at a number of management levels (see 2.7)a)1). The economic appraisal of projects of the Branch is now a matter of direct concern to Branch staff. This is a complex subject, in which varying degrees of progress and precision may be anticipated according to the degree of proximity between the research project and the potential user of results. In such fields as forest products, forest regeneration, forest inventory and certain aspects of protection there is an element of immediacy between the project and the operator, and it is in these fields that economic analysis of projects is expected to make its first contribution. Steps have been taken to learn some of the problems in these specific fields and to develop procedures that may be helpful in program evaluation.

2.7)a)4 From 1965-66 to 1968-69 inclusive, contracting out development projects in support of intramural programmes has resulted in fifty-four projects with a total expenditure of $157,410 (sub-totals by sector and activity are shown in Appendix 2.7)a)4).

2. Numbers of contracts by activity are:

(a)	Resource and Management Research	- 31
(b)	Forest Protection	- 8
(c)	Forest Products	- 10
(d)	Forest Economics	- 3
(e)	Application of Research Findings	- 2

3. Sectors in which contracts have been let are: (a) Industry, (b) University, (c) Consultants (forestry and other), (d) Provincial Agencies, and (e) Former Employees. Examples of contracts let in these sectors follow:

(a) Industry - A contract with a pulp and paper company in Alberta calling for the company to pre-treat and carry out prescribed burning of spruce and pine logging slash according to Forestry Branch prescription amounted to an expenditure of $3,200 over a 2-year period.

(b) University - In support of the insect control program, a Maritime university was given a contract to analyse for DDT residues, following spraying for control of the spruce budworm, in samples of foliage, soil, and livers of small animals. The contract amounted to $5,200 over a 3-year period.

(c) Consultants - A contract to develop and test a machine for harvesting black spruce cones - with concurrent time studies of normal hand picking - was entered into with a forest consultant in Ontario. The contract amounts to $17,000.

(d) Provincial Agencies - A contract in the amount of $7,000 has been awarded to a provincial Research Council to carry out a preliminary systems study of the proposed growing, transportation, planting and establishment of tree seedlings

in containers under British Columbia conditions, with the objective of assessing the effect of the design of the system at each stage on the overall economics.

(e) Former Employees - A former employee was placed on contract to analyse data and prepare a final report on a study of the European Pine Shoot Moth which had been a part of his program before he accepted a position outside government. The contract was for $2,400.

2.7)a)5 The Branch policy regarding the funding of extramural research programs in universities and other research institutes is that these programs are simply an extension of research conducted within Branch laboratories. Quite often certain scientific information can be obtained more economically by making use of outside facilities. Subsidiary benefits from these grants include the development and support in the scientific community of an interest in forestry sciences that will have a potential value for the long-term development of forestry in Canada; it is also anticipated that these grants will assist in the staffing of various establishments of the Branch with promising young scientists.

2. Extramural research grants to universities during the past five years are tabulated below. Grants to two provincial research councils in the amount of $22,250 have also been made.

Year	Numbers of Universities	Amounts Granted
1964-65	6	$ 54,240
1965-66	8	58,390
1966-67	13	88,900
1967-68	16	173,800
1968-69	16	195,800
	Total	$571,130

2.7)a)6 Shifting resources from one program to another, and occasional program termination, is a continuing process in response to changing demands. It is done through reassessment of priorities and phasing into new work. Difficulties sometimes occur when staff trained and experienced in a particular type of work cannot easily be moved to a new program, but these may be at least partially offset by transfers or special retraining courses, and by recruitment of project leaders to head up the new lines of work.

2.7)a)7 One of the principal means of communicating research results to those having potential need of them is through publications and the distribution of reprints. The main publications used by Forestry Branch are scientific and technical journals, the forestry trade magazines, special regional newsletters, and departmental research publications, of which thousands are distributed annually.

2. To supplement the medium of publication, the Forestry Branch has developed more direct methods to transfer research findings to the potential users. Three aspects are delineated: (1) liaison with the various agencies to communicate research information and, also, to learn of the problems of the user; (2) development work whereby projects are carried beyond the stage of research findings and the potential for practical application is demonstrated to the ultimate user; (3) forestry services which are of an advisory or consultative nature designed to assist governmental agencies and the private sector in developing methods for more efficient management and use of the forest resources.

3. The general approach of the Forestry Branch is to make all research groups conscious of the importance of liaison, development, and forestry services, and to get as many staff members as possible directly involved in this activity. In addition, 37 professionals and 126 man-years of support staff have been specifically allocated to this area of work. These individuals are largely involved with silviculture, management, products and economics activities and work closely with industry, the universities and provincial agencies on a cooperative basis, or arrange through contracts to have development projects carried out. They are employed at all regional establishments, the Forest Management Institute, Petawawa Forest Experiment Station, and the Forest Products Laboratories.

4. Liaison is maintained with other federal and with provincial government agencies, industrial organizations, and other agencies

for the dual purpose of communicating research results to forest managers and, also, to provide a "feed-back" service to the research organizations with respect to problems of the managers. Such liaison is generally effected by direct contact, but also by the preparation of special reports and articles providing interpretation and synthesis of highly technical research findings and by the preparation of pertinent bibliographies. An important liaison function is also served by participation in workshops, symposia, professional conferences, and meetings of standards associations.

5. The following are a few examples of recent developmental or demonstration types of work carried out at regional establishments: (1) demonstration and economic evaluation of the technique of container planting, involving cooperation between the British Columbia Regional Establishment, the British Columbia Forest Service, the Forestry Faculty of the University of British Columbia, the industry, and the British Columbia Research Council; (2) demonstration of equipment that can be used in preparing sites for reforestation on barren and bog-land in Newfoundland; (3) adaptation of agricultural equipment for use in forest tree seeding in Ontario, and (4) testing and demonstrating combined scarification and aerial seeding as a means of regenerating large burned-over areas in the Province of Quebec.

6. Advisory, consultative, or direct forestry services are provided to a number of other federal government agencies, including forest surveys, forest protection, and timber disposal on Department of National Defence areas, notably Bases Gagetown, Valcartier, Petawawa, Borden, and a number of smaller establishments in eastern Canada. Forest surveys and consulting services are also provided for the Departments of Indian Affairs and Northern Development, Justice, and Transport.

2.8 Research Output

The more usual ways in which the research activities of the Forestry Branch contribute to the forestry and scientific interests in Canada are discussed below.

2.8 (1) Only a few results or processes arising from forestry research are patented. Most of these in the past have arisen from forest products research. During the last five years, action has been taken to obtain four patents, but only one has yet been patented.

(a) Process for pulping lignocellulosic materials (Can. Pat. 725,529; U.S. Pat. 3,218,226).

(b) Fire-retardant treatment of wooden shingles and shakes.

(c) Thermal wood cutting process.

(d) Phosphorycating agent for cellulose.

There is no record of the value that the one process now patented may have contributed.

2.8)2 and 3 Books and journal articles arising from forest research activities, and reports issued from the Forestry Branch during a recent five-year period are shown below.

Period	Books and Journal Articles	Reports
1962-63	292	275
1963-64	301	285
1964-65	293	250
1965-66	342	245
1966-67	383	276

Books and journal articles have ranged from one page to 330 pages in length, averaging about 10 pages per article. Reports range from five to 250 pages, and average about 20 pages. In addition, many interim file and progress reports though not distributed widely are available for loan on request.

2.8 (4) An important method for disseminating results of forest research to extramural groups is through attendance at conferences, seminars, workshops, symposia, etc. Scientists and research managers participate in these meetings as discussion leaders, panel moderators; they deliver scientific papers or lead field excursions and demonstrations; and give lectures as part of training programs. These meetings cover all subject matter and disciplines with which the forest research program is concerned, and a great many are attended by forest managers or members of the forest industry, who are concerned with implementing results of forest and forest products research. Personal contacts and discussion that take place outside of formal sessions contribute greatly toward dissemination of research results.

2. The policy of Forestry Branch is to provide an average of about $180 annually for each professional officer to be used on non-government business travel, which is mainly to attend conferences in Canada and the United States. Costs of conferences outside North America are additional and funds are provided to meet essential needs.

3. An indication of the breadth of scientific interest in the Forestry Branch and the number of extramural contacts that are made can be obtained from Appendix 2.8 (4). This is a list of the national and international meetings attended by Branch personnel during the last five years. Many of these are annual meetings, whereas others are held at two, three, five-year, or even longer intervals.

2.8 (5) The Branch has a continuing program of exchange of scientific and technological data that provides a source of information from abroad and is available to extramural groups in Canada. The Library contributes to this service in three ways.

(a) Through agreements, publications are exhanged with nearly 500 scientific and government organizations throughout the world.

(b) A list of items added to the library is published monthly and distributed widely in Canada and abroad.

(c) Inter-library loans are maintained with libraries all over the world. When copyright laws permit, most libraries are now sending photostatic or micro-filmed copies for retention by the borrower.

2. The International Liaison Officer is responsible for distribution within Canada of the scientific and technological publications of international forestry organizations to other federal departments, provincial governments, forestry schools, industry associations and research institutes, as well as individuals concerned with forestry matters. These include:

(a) Quarterlies, yearbooks, technical monographs, periodicals, directories, and miscellaneous reports published by FAO and its statutory bodies, the Timber Committee of the Economic Commission for Europe (ECE) and those of the ECE/FAO/ILO Committee on Forest Working Techniques and Training of Forest Workers, all of which are received through the office of the Secretary of the FAO Interdepartmental Committee.

(b) Publications dealing with forestry published by the Organization for Economic Co-operation and Development (OECD) and received through the United Nations Documents Section of the Department of Fxternal Affairs.

(c) Commonwealth Forestry Institute reports.

(d) Publications and reports prepared by the forestry departments of Commonwealth countries for Commonwealth Forestry Conferences.

2.8 (6) About 3 or 4 per cent of the professional staff of the Forestry Branch resign each year to accept employment elsewhere. During the last few years, 70 per cent of resigning professionals have had no more than four years experience, but most of the remainder were well-established scientists who accepted senior staff appointments at Canadian universities. A few have gone to universities or other organizations outside Canada.

2. Among these have been a few outstanding scientists who have gone on to making important contributions. The dates these resigned, their specialties, and the organizations employing them are listed below:

(a) 1947 - photogrammetrist - Abitibi Paper Co. - forest surveys, research

(b) 1955 - silviculturist - North Western Pulp and Power Ltd. - forest management operations

(c) 1956 - forest pathologist - University of British Columbia - teaching, research

(d) 1956 - forest land classification - Consulting firm - forest land classification consulting

(e) 1956 - tree physiologist - University of Toronto - teaching, research

(f) 1959 - forest entomologist - University of California - teaching, research

(g) 1961 - insect pathologist - Washington, D.C.

(h) 1962 - forest ecologist - University of Wisconsin - teaching, research

(i) 1963 - bio-mathematician - University of California - teaching, research

(j) 1965 - wood chemist - University of British Columbia - Dean, Faculty of Forestry

(k) 1966 - silviculturist - Self employed - forest consulting

(l) 1966 - forest hydrologist - University of British Columbia - teaching, research

(m) 1967 - systems ecologist - University of British Columbia - teaching, research

(n) 1967 - forest ecologist - University of Saskatchewan - teaching, research.

2.8 (7) By nature, many forestry problems require long-term research for solution and their investigation involves several biological disciplines. It is standard practice to assemble research teams when programming work. Usually these comprise professional staff of a unit set up under a designated leader for as long as required, usually for two to several years. Typically, a team would contain specialists from several fields, e.g., silviculture, ecology, soils, mensuration, economics, entomology, pathology, fire control, etc.

2. When the specialists needed to investigate an important problem are not available within the Branch, they are recruited. Recently, a new project was undertaken at the Vancouver Forest Products Laboratory to appraise pulping techniques and to develop new or better pulping processes. The team recruited is unique in Canada and includes a leader with training in chemistry, chemical engineering, and economics, and four other specialists competent to do research in pulping processes, bleaching, and the utilization of carbohydrates and lignin.

3. Another type of forestry project may require specialists from several organizations. An example that is unique in Canada is the watershed research team established recently in Alberta to investigate means of improving and regulating the quality and supply of water originating on the forested mountain slopes of the south Saskatchewan River Watershed. This project required input from forest hydrologists, ecologists, silviculturists, grassland specialists, geologists, pedologists, hydrologic engineers, wildlife biologists, entomologists, pathologists, and chemists. The Forestry Branch has provided the project leader, who coordinates the activities of several Forestry Branch specialists and scientists representing the above-mentioned disciplines from four other federal agencies, four agencies of the Province of Alberta, and a federal-provincial Board.

4. In 1968, a research team was established within the

Branch to investigate means of reducing the cost of harvesting and transporting logs and pulpwood. An internationally-known scientist was recruited to coordinate the isolated and relatively small projects now underway in about 12 units of the Branch and to develop a comprehensive and fully integrated program. This program will be coordinated with harvesting research being done by other Canadian groups, especially the pulp and paper industry.

2.8 (8) Many new and valuable research tools and facilities have been developed during the last five years by scientists in the Forestry Branch. A high proportion of them are new techniques in chemistry and biology that increase the sophistication of our research program, while others improve application of results. A few of the unique and most valuable in each of the major research activities are:

(a) Resource and Management

(i) Simulation of forest stands on computers for analyzing harvesting systems.

(ii) Development of large-scale aerial photography for use in forest inventories.

(iii) Developments in the use of container planting in reforestation.

(b) Tree Biology

(i) Use of radioisotopes for identifying nitrogen compounds led to discovery of formerly unknown compounds in plant tissues.

(ii) Tissue culture techniques to permit growing embryoes of woody plants from single cells.

(iii) Techniques for identifying compounds in tree bark.

(iv) New methods for storing parts of trees alive for propagation purposes.

(c) Forest Protection

(i) New modelling techniques for predicting changes of population and behaviour of forest insects.

(ii) Artificial nutrient media for rearing several species of forest insects.

(iii) New methods for identifying insect viruses.

(iv) Bio-assay and serological techniques for identifying fungus pathogens on trees.

(v) The recognition of antibiotic potential in a wood-destroying fungi for application in disease control in agriculture, forestry and medicine.

(vi) A system of forecasting forest fire hazard daily.

(vii) Apparatus to measure fire resistance of wood.

(viii) New techniques for estimating quantities of fuel on the forest floor.

(d) Forest Products

(i) An apparatus using rheological compression behaviour to assess timber strength.

(ii) High temperature schedules for kiln-drying timber.

(iii) New processes for inspecting marine piling.

(iv) New processes for inspecting glue curing processes in plywood and other laminated products.

(v) New processes and facilities for manufacturing particle board.

2.8 (9) The impact of the Forestry Branch's scientific activities on the advancement of scientific knowledge is measured to some degree by the numerous requests received for technical results or collaborative work, and by the numbers and the calibre of scientists from Canada and abroad who visit our scientists in their laboratories or in their research forests. Leading forest scientists and professors from Canada, as well as from numerous other countries, spend periods ranging from a day to several weeks with Forestry Branch scientists, who, in turn, are invited to travel widely, lecture, and share research programs or appraise technological advances. Many results of our scientific activities are implemented abroad.

2. It is difficult and rarely possible to determine and measure independently the impact on the Canadian economy of implementing the results of only one element of a research program. In general, implementation of research results is reflected at least in part in the rate of growth of the forest economy, which has been expanding continually in Canada. This has been associated with an increasing direct involvement of our research staff with their professional counterparts in provincial forest services, industrial organizations, and other research and development agencies, and the introduction or adaptation of many results of the Forestry Branch program into operational practice. Examples are:

- forest land classification, mapping, capability rating
- site preparation as an aid to regeneration and reforestation
- increased yield through forest fertilization
- improved inventory procedures through use of large scale aerial photographs and newly developed altimeter
- simulation studies of stand development and harvesting practice as an aid to harvesting methodology and equipment design
- silvicultural use of fire in stand conversion and renewal

- fire hazard rating and fire weather forecasting
- fire detection and use of infra-red scanner
- performance studies of water bombing aircraft
- studies of fire control strategy, relative to differential rates of expenditure on detection, pre-suppression and suppression activities
- detection and appraisal of insect outbreaks, all regions, but particularly Newfoundland, New Brunswick, Quebec, Ontario and British Columbia
- insect control investigations and direct contributions to control operations utilizing insecticides, introduced parasites and pathogenic microorganisms
- studies of pesticide residues and hazards to non-target species, modifications of insecticide formulations and methods of application to reduce undesirable side-effects
- control of forest nursery diseases
- contributions to management of mature timber stands affected by timber decays
- development of non-destructive tests of strength in structural timbers
- prevention of stain in packaged green lumber
- improved packing cases for several types of commodities to provide protection during shipping, handling and storage
- more economical seasoning of lumber
- quality control in plywood manufacturing, through devices to improve uniformity in veneer thickness and detect gaps in glue line
- pulping of "weed" species and degraded wood
- economic studies of reforestation
- studies of production and use of construction grade plywood

2.9 **Projects**

2.9 (1) The aim of the program of the Forestry Branch is to gain, by means provided through enabling legislation, an improved knowledge and understanding of the forest estate of Canada; to use this knowledge as a basis for fostering improved management and prescribing improved protection; to promote more effective multiple use of the forest resource, more effective utilization of wood and the reduction of waste; thereby to improve the utility of the resource and the competitive position of Canada's forest industries.

2. Because an individual area of forestland does not produce a crop of trees annually, research in forest management and utilization must be built up of a series of coordinated projects that extend over a considerable range of the rotation period for the crop rather than of projects that are completed in only a few months or a year. The Forestry Branch program has a coordinated group of complex projects supported by specialists in a large number of fields who do research in laboratories, nurseries, forests and factories, often quite widely separated because of the wide geographical range of many of Canada's important tree species and forest types.

3. To achieve its objectives, the Branch has subdivided its total program into seven major activities, each of which may have several sub-activities and many minor projects. The program of research within these major activities is briefly described below. Sub-Activities are discussed in Appendix 2.9 (1).

Activity 1 - Resource and Management Research

4. Forest resource and management research embraces five sub-activities: forestland classification, forest soils, forest inventory and mensuration, silviculture, and tree biology. These five sub-activities are interrelated through their practical objective of maximizing forest production. Studies of forestland and soils establish the framework within which the use of forests must be planned. Forest mensuration defines problems and describes

growth and inventories of forests in quantitative terms to provide the base for the economic operation of forests. Silviculture is concerned with developing methods of forest establishment, manipulation, and harvesting, and is based upon synthesis of biological and operational information derived from other fields. Studies in tree biology provide fundamental information on the ecology, taxonomy, physiology, genetics, nutrition, and anatomy of Canadian tree species.

5. This major activity is conducted at all regional establishments and at two Institutes (Forest Management Institute in Ottawa, and Petawawa Forest Experiment Station at Chalk River). Concurrent studies range from basic investigations of forest ecosystems and the functions of their component parts, through applied studies of how the forest resource can best be appraised and manipulated, to pilot trials and large-scale testing of promising techniques undertaken in conjunction with forest industry and provincial forest services.

6. Resource and management research is directed toward the development of efficient techniques for the establishment, growth, and harvesting of forests. A primary objective is to ensure continuing and improved supply of raw material to forest industries. However, increasing attention is being given to techniques that will assist in the management of forests for less tangible but equally vital values concerned with the contribution of the forest resource to other industries such as tourism, recreation, the preservation of wildlife habitats, the protection of water resources and climate.

7. During 1968-69, the professional staff engaged in resource and management research was 184, with a support staff of 312 man-years, equivalent in total to about 23% of the Forestry Branch staff.

<u>Activity 2 - Forest Protection</u>

8. Fire, insects and disease play major roles in the cycle of growth, decay and rejuvenation of the forests, and controlled

fires are often used as a silvicultural tool. However, outbreaks of these major forest influences threaten our forest economy by a loss that has been estimated at about 2 billion cu. ft. of wood per year. Protection problems are most acute in softwood forests, which comprise our major commercial species. They constitute stands that are most susceptible to fire -- the different species showing different flammability characteristics. They also rate high in vulnerability to attack by insects and diseases. Vulnerability tends to be highest in older mature stands, such as those that are still relatively inaccessible. Those that succumb to insect or disease attack themselves constitute a high fire hazard, and thereby create a strong interrelationship between these forest influences. The Forestry Branch's objectives in forest protection are to provide the basic information necessary for advising forest managers on the most effective means to provide protection against fire, insects and diseases. The Branch also conducts surveys of pests, as well as of the damage caused by them.

9. During 1968-69, 661 man-years (professional and support staff) are expended on protection research. This is equivalent in total to about 30% of the Forestry Branch staff.

Activity 3 - Forest Products

10. The objective of the research program carried out at the two Forest Products Laboratories is to promote increased efficiency and maximum utilization in timber harvesting and in conversion of wood to saleable products. In 1968-69, the research strength is 99 professional man-years and 149 man-years of technical support. This is equivalent to 11% of the Forestry Branch staff. This major activity of research is generally considered under eight sub-activities.

Activity 4 - Forest Economics

11. The objectives of this activity are to carry out studies that will:

(a) Appraise Forestry Branch programs for economic priority.

(b) Evaluate wood costs and productivity.

(c) Provide an understanding of the full potential for many uses of forest resources.

(d) Analyse the structure of forest industry and inter-industry relationships in Canada.

(e) Appraise present and future consumption patterns, levels of demand and the impact of trade and monetary policies on marketing forest-based commodities.

(f) Develop and adapt economic and statistical models to forest-based activities.

12. In 1968-69, a total of 62 man-years has been devoted to research in forest economics. This is equivalent to about 3% of the Forestry Branch staff. Part of this research program must be closely coordinated with the research in other major activities, and this is achieved by assigning economists to the task force set up to carry out a major project.

13. Research in economics requires development of analytical procedures and appraisal of techniques and methods of retrieving information that can be applied to the forest economy.

Activity 5 - Application of Research Findings

14. There are three aspects that are delineated under this major activity - (a) liaison, (b) research development, and (c) demonstration. They involve in 1968-69 a total of 163 man-years or approximately 8% of the total staff of the Forestry Branch. Details of this portion of the program are presented in Section 2.7 (a) under communication of results of research.

Activity 6 - Research Services

15. This activity can be subdivided into four sub-activities. Each is the responsibility of the following service units: Biometrics, Library, Scientific Editing, and Photographic and Drafting. In 1968-69, 134 man-years are involved and this is approximately 6% of the total of the Forestry Branch.

Activity 7 - Research Administration and Management

16. The remainder of the staff of the Branch is responsible for the administration and management of the research program. This

amounted in 1968-69 to 409 man-years or 19% of the total. This portion of the staff is responsible first of all for directing and coordinating the total research program of the Branch. In addition, they provide service relating to personnel management, purchasing, inventory maintenance, budgetary control. The engineering and maintenance staff is responsible for the maintenance of research laboratories, greenhouses, etc.

2.9 (2) Sixteen case histories of what are considered to be among the most significant and best projects completed by the Forestry Branch within the last five years are given in Appendix 2.9 (2). These are presented under three categories as follows:

Basic Research

- Cellular physiology and biochemistry of conifers
- Chemistry of western red cedar
- The dynamics of epidemic spruce budworm populations
- Cryptosporiopsin - an antibiotic produced by cryptosporiopsis sp., a fungus isolated from yellow birch
- Bacillus thuringiensis as an insecticide

Applied Research

- Development of a large-scale aerial photography -- radar altimeter system of forest and land inventories
- Non-destructive testing of construction lumber
- Simulation models for tree harvesting machines
- Forest fire hazard forecasting
- Control of dwarf mistletoe in lodgepole pine stands
- Laboratory evaluation of insecticides against forest insects, with special reference to the development of insecticide resistance

Developmental Research

- The use of cutting classes in forest surveys
- Development of an airborne infrared forest fire mapping and detection system
- Veneer production instrumentation
- A moment connector for glued-laminated timbers
- Growing and planting forest trees in containers

2.10 Organizations not currently engaged in scientific activities

2.10 (1), (2),(4) The Forestry Branch program, because it is mainly research oriented rather than operational, by its very nature can be readily altered to implement and to take advantage of advances in technology. Examples of areas of research that are likely to be affected by various innovations are discussed below.

Resource and Management Research

2. Surveys aimed at classifying land and recording damage by insects, diseases and fire are likely to be enhanced through advances in air-photo interpretation procedures. Technological improvements can be expected in new sensing techniques, orbital imagery, colour and false-colour photography, and attendant interpretation methodology.

3. To remain competitive, the forest industry in Canada must make new technological advances in mechanized harvesting. This will present new problems in silviculture and forest management. Silviculturists may be expected in the future to produce forests that have the necessary structure and uniform size over large areas to accommodate revolutionary harvesting equipment. This will require investigation of problems in the utilization of whole trees, and will also bring about new concepts and approaches to regeneration, promotion of rapid growth, and measurement of forest production.

Tree Biology

4. Changes in technology will no doubt have important influences on research in tree biology and soils. Changing techniques of harvesting, reforestation and site amelioration will have major effects on soil flora, fauna, and physical and chemical properties, making necessary much work in soils research to assess and develop new procedures. Likewise, advances in pulp and paper technology will alter the types of raw material and tree species required for pulp and paper and other products derived from wood and this will have an important influence on program objectives in forest genetics and tree improvement.

Forest Protection

5. Increased use of mechanical harvesters will lead to establishment of man-made forests that will be uniform in species composition and age over vast areas. This will result in higher populations of insects and diseases in the young stands, plantations and nurseries. The Forestry Branch's research program in protection will be greatly influenced. Methods for controlling insects and diseases will become more selective. Proponents of chemical control will work towards ultra low-volume sprays which will tend to reduce costs and hazards. In special cases, chemical control will be replaced by biological controls of various kinds, including sterilization techniques for harmful insects, and the use of antibiotics against tree diseases.

6. Important advances are being made in the use of infra-red film for fire detection and mapping. This and other developments will tend to modify future fire research and control programs. This is true also with respect to improvements in the use of chemical retardants for short and long-term fire suppression. If cheap 'packaged' power became available, surveillance and suppression helicopters might be employed to hover over fixed points at heights of 1,000 to 2,000 feet on 24-hour duty, when desirable. Provision of such facilities would necessitate a radical redirection of forest fire research programs.

Forest Products

7. Continuous modification of the research and development programs in wood utilization is being experienced because of new developments. Such innovations as the following are expected to have major effects on wood utilization research: (a) engineering developments in mechanical harvesting equipment will have far-reaching effects on wood procurement; (b) new technology will assist in development of new means for non-destructive determination of wood strength, extent of decay, moisture content, and specific gravity; (c) new technology in the physical and engineering sciences will permit the development of revolutionary methods of

cutting and shaping wood with minimum saw-kerf and much improved surface properties; and (d) new chemistry technology could lead to new pulping processes giving higher yields and more valuable by-products, and with much reduced pollution effects.

2.10 (3) The Forestry Branch, in the normal operation of its program, seeks scientific and technical advice in a number of areas, such as:

- disciplines that are peripheral to those normally covered by the Branch staff
- other agencies concerned with the same forestry disciplines to ensure coordination or collaboration
- forest management agencies and wood-based industries for advice on priorities for problems requiring study
- agencies setting specifications for such things as insecticides, herbicides and fertilizers
- taxonomists concerned with special groups of insects or fungi
- agencies with facilities for equipment modification or development

This type of assistance is obtained from:

- other federal departments and agencies such as the National Research Council, Atomic Energy of Canada Limited, Department of Agriculture, Department of Energy, Mines and Resources, Department of Transport, National Museum, etc.
- Canadian and foreign universities
- provincial and private research foundations
- Canadian Standards Association
- forest industry agencies or associations such as the Pulp and Paper Research Institute of Canada, or the numerous Lumbermen's Associations
- Canadian manufacturers of chemicals, data processing equipment, and machinery, etc.
- research organizations of foreign governments
- international research organizations, for example, the International Union of Forestry Research Organizations

2. Other scientific and technical agencies seek advice from members of the Forestry Branch on a wide range of topics, a few

of which are:

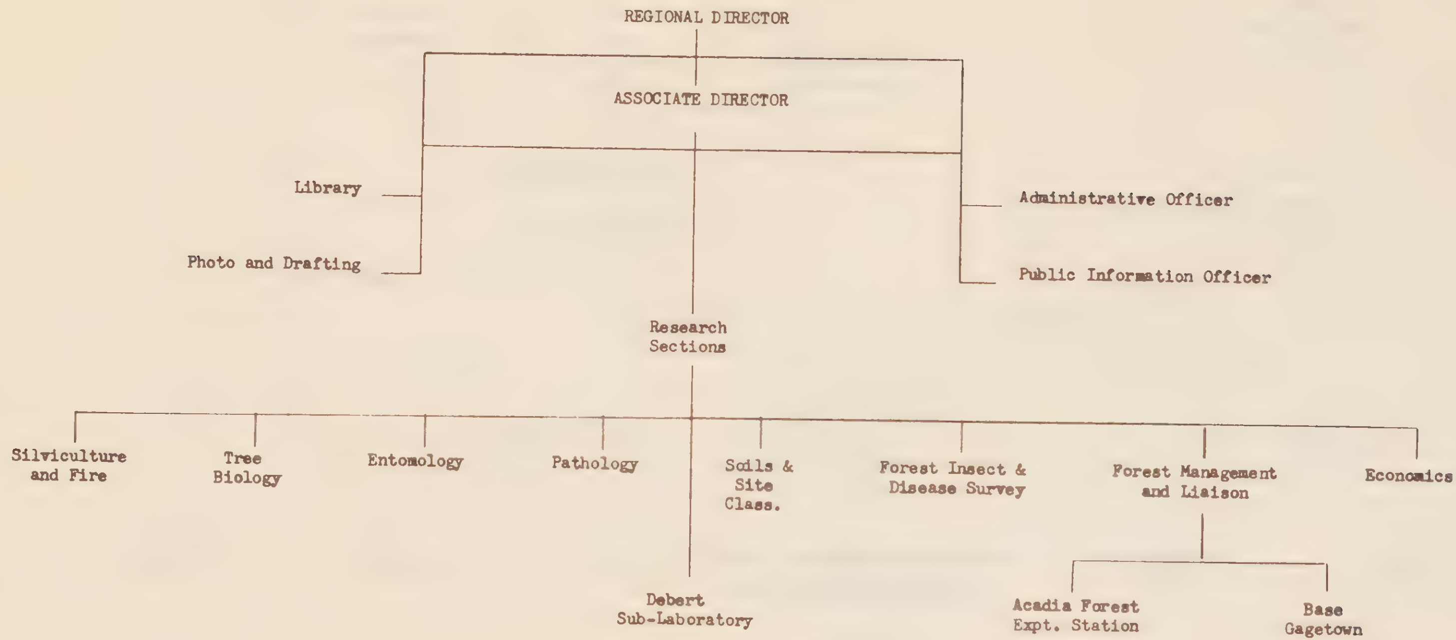
- reviewing manuscripts of scientific articles proposed for publication
- consultation in methods of protection and control of pests and fire
- development of new uses of wood
- establishment of standards for wood and wood products
- training personnel on the job
- feasibility studies of new procedures and processes

APPENDIX 2.1)c)i

FOREST RESEARCH ESTABLISHMENT

MARITIMES REGION

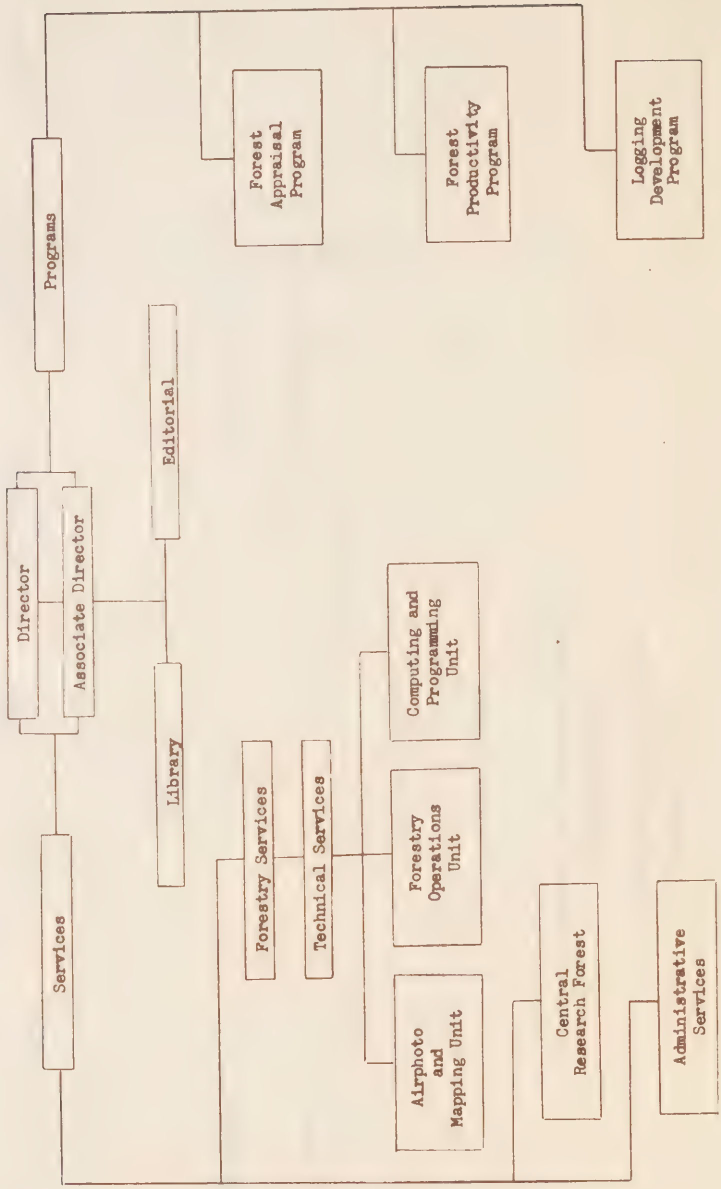
DEPARTMENT OF FISHERIES AND FORESTRY



APPENDIX 2.1)c)ii

FOREST MANAGEMENT INSTITUTE

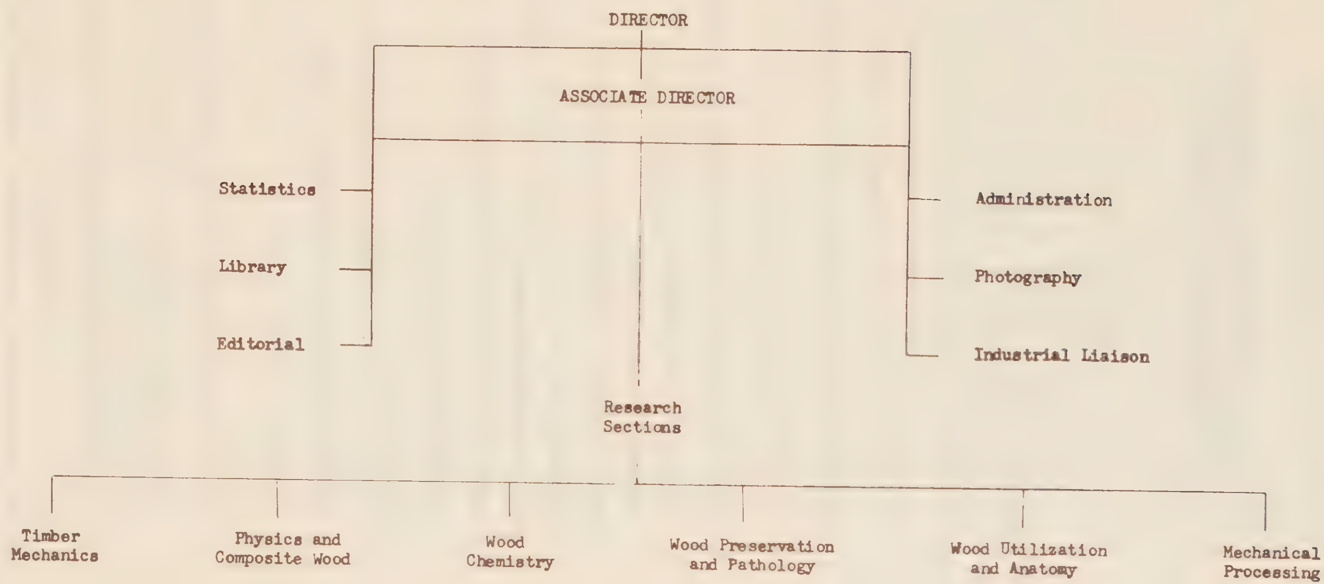
DEPARTMENT OF FISHERIES AND FORESTRY



APPENDIX 2.1)c)iii

OTTAWA FOREST PRODUCTS LABORATORY

DEPARTMENT OF FISHERIES AND FORESTRY



APPENDIX 2.2 (a)

EXTRACTS FROM THE FORESTRY DEVELOPMENT AND RESEARCH ACT (OFFICE CONSOLIDATION) RELATING TO SCIENTIFIC ACTIVITIES OF THE FORESTRY BRANCH

PART I

DEVELOPMENT AND RESEARCH

6. (1) Subject to section 24 of the Government Organization Act, 1966, respecting the duties, powers and functions of the Minister in relation to the forest resources of Canada over which the Parliament of Canada has jurisdiction, the Minister

(a) shall provide for the conduct of research relating to the protection, management and utilization of the forest resources of Canada and the better utilization of forest products and may establish and maintain laboratories and other necessary facilities for such purposes;

(b) may undertake, promote or recommend measures for the encouragement of public co-operation in the protection and wise use of the forest resources of Canada;

(c) with the approval of the Governor in Council, may enter into agreements with the government of any province or with any person for forest protection and management or forest utilization, for the conduct of research related thereto, or for forestry publicity or education;

(d) may provide for the making of forestry surveys and provide advice relating to the protection and management of forests on lands administered by any department or agency of the Government of Canada or belonging to Her Majesty in right of Canada; and

(e) at the request of any department or agency of the Government of Canada, may assume responsibility for the protection and management, including the disposal of timber and other forest products, of any forest on lands administered by such department or agency.

(2) In carrying out his duties and functions under this Act, the Minister may consult with and inaugurate conferences of provincial or municipal authorities, universities, representatives of industry or other interested persons.

(3) The Minister may conduct economic studies relating to the forest resources, forest industries and marketing of forest products, make investigations designed to aid the forest industries and woodlot owners of Canada and assist external aid programs relating to forestry.

(4) The Minister has, in relation to silviculture, the like powers, duties and functions as he has under this Act in relation to the protection and management of the forest resources of Canada, and the Minister has in relation to the disposal of grass and forest products and to the granting of grazing rights or other rights in respect of the natural produce of the soil, the like powers as he has under this Act in relation to timber.

PART II

FOREST EXPERIMENTAL AREAS

7. The Governor in Council may establish as a Forest Experimental Area

(a) lands belonging to Her Majesty in right of Canada; and

(b) lands provided therefor, pursuant to an agreement with the government of any province, by the government of the province or any person in the province;

and may at any time withdraw lands from or add lands to a Forest Experimental Area.

8. Subject to this Act, the Minister may within any Forest Experimental Area do such acts and construct such works as he deems necessary for forest protection and management, including the disposal of timber and other forest products, and for forest research.

9. Subject to section 7, the Governor in Council may make regulations for the protection, care and management of Forest Experimental Areas, and, without restricting the generality of the foregoing, may make regulations respecting

(a) the cutting, removal and disposal of timber, the establishment and use of reservoirs, waterpower sites, power transmission lines, telegraph and telephone lines, and any other use not inconsistent with the purposes of this Act, and the granting of leases and permits therefor;

(b) the protection of the flora;

(c) the prevention and extinguishment of fires in or threatening a Forest Experimental Area;

(d) the regulation and prohibition of traffic and the carrying on of businesses and other activities in Forest Experimental Areas, and the abatement and prevention of nuisances therein;

(e) the removal and exclusion of trespassers and of persons failing to comply with the regulations; and

(f) the prevention of trespass, mutilation or destruction of trees and destruction or damaging of buildings, materials or notices used in connection with the administration or management of any Forest Experimental Area.

APPENDIX 2.2 (d)

EXAMPLES OF SUBJECT MATTER COVERED INFORMALLY BY DISCUSSION BETWEEN RESEARCH STAFF OF THE FORESTRY BRANCH AND THEIR PROFESSIONAL COUNTERPARTS IN THE FORESTRY COMMUNITY OF CANADA

1. Forestland classification, mapping, capability rating.
2. Site preparation as an aid to regeneration and reforestation.
3. Increased yield through forest fertilization.
4. Improved inventory procedures through use of large-scale aerial photographs and newly-developed altimeter.
5. Simulation studies of stand development and harvesting practice as an aid to harvesting methodology and equipment design.
6. Silvicultural use of fire in stand conversion and renewal.
7. Fire hazard rating and fire weather forecasting.
8. Fire detection and use of infrared scanner.
9. Performance studies of water bombing aircraft.
10. Studies of fire control strategy, relative to differential rates of expenditure on detection, pre-suppression and supression activities.
11. Detection and appraisal of insect outbreaks, all regions, but particularly Newfoundland, New Brunswick, Quebec, Ontario, and British Columbia.
12. Insect control investigations and direct contributions to control operations utilizing insecticides, introduced parasites, and pathogenic microorganisms.
13. Studies of pesticide residues and hazards to non-target species, modifications of insecticide formulations and methods of application to reduce undesirable side-effects.
14. Control of forest nursery diseases.
15. Contributions to management of mature timber stands affected by timber decays.
16. Development of non-destructive tests of strength in structural timbers.

17. Prevention of stain in packaged green lumber.

18. More economical seasoning of lumber.

19. Quality control in plywood manufacturing, through devices to improve uniformity in veneer thickness and detect gaps in glue line.

20. Pulping of "weed" species and degraded wood.

21. Economic studies of reforestation.

22. Studies of production and use of construction grade plywood.

APPENDIX 2.5)c)i

COUNTRY OF BIRTH

Country (current name)	Degree Level and Numbers		
	Bachelor	Master	Doctor
Argentina	-	-	1
Australia	-	-	1
Austria	-	-	2
Belgium	1	3	1
Canada	97	105	100
China, Nationalist	-	2	-
China, People's Republic	1	1	6
Cuba	1	-	-
Cyprus	-	1	-
Czechoslovakia	1	-	3
Denmark	-	1	2
Finland	1	-	1
France	1	2	-
Germany, East	-	1	1
Germany, Federal Republic	1	2	5
Greece	-	-	1
Haiti	-	1	-
Hungary	3	12	4
India	-	3	14
Indonesia	-	-	1
Ireland	-	-	1
Jamaica	-	-	3
Japan	-	-	4
Korea, North	-	-	1
Netherlands	3	5	1
New Zealand	1	-	1
Norway	-	-	1
Pakistan	-	-	5
Philippines	-	1	2
Poland	4	2	-
Romania	-	-	2
Singapore	-	-	1
South Africa	-	1	-
Spain	-	-	1
Sweden	-	-	1
Switzerland	1	1	2
Thailand	-	1	-
Turkey	-	-	2
U.S.S.R.	2	5	3
United Arab Republic	1	-	-
United Kingdom	11	13	34
United States	3	17	18
Vietnam, South	-	-	1
Yugoslavia	-	1	-
Zambia	-	1	-
	133	182	227

APPENDIX 2.5)c)ii

COUNTRY IN WHICH SECONDARY EDUCATION TAKEN

Country	Degree Level and Numbers		
	Bachelor	Master	Doctor
Argentina	-	-	1
Australia	-	-	1
Austria	1	-	1
Belgium	1	3	-
Canada	106	114	110
Ceylon	-	1	-
China, Nationalist	-	1	1
China, People's Republic	-	1	2
Cuba	1	-	-
Cyprus	-	1	-
Czechoslovakia	1	-	2
Denmark	-	2	2
Finland	-	-	1
France	-	2	-
Germany, East	-	-	1
Germany, Federal Republic	-	2	5
Greece	-	-	1
Haiti	-	1	-
Hungary	3	11	4
India	-	2	16
Israel	1	-	-
Ireland	-	-	2
Jamaica	-	-	3
Japan	-	1	4
Korea, North	-	-	1
Netherlands	1	5	3
New Zealand	1	-	1
Norway	-	-	1
Pakistan	-	-	2
Philippines	1	1	1
Poland	2	1	-
South Africa	-	1	-
Spain	-	-	1
Sweden	-	1	-
Switzerland	2	-	-
Thailand	-	1	-
Turkey	-	-	2
U.S.S.R.	1	1	2
United Arab Republic	1	-	-
United Kingdom	7	11	32
United States	3	17	20
Vietnam, South	-	-	1
Yugoslavia	-	1	-
Undeclared	-	-	3
	133	182	227

APPENDIX 2.5)c)iii

COUNTRY IN WHICH DEGREE TAKEN

Country	Degree Level and Numbers		
	Bachelor	Master	Doctor
Australia	-	-	1
Austria	1	-	-
Belgium	1	2	-
Canada	109	101	76
Cuba	1	-	-
Denmark	-	1	-
Finland	-	-	1
France	1	1	2
Germany, Federal Republic	-	1	6
Haiti	-	1	-
Hungary	1	-	1
India	-	1	4
Japan	-	1	3
Netherlands	-	1	1
New Zealand	1	-	-
Pakistan	-	1	-
South Africa	-	-	1
Spain	-	-	1
Sweden	-	1	1
Switzerland	1	-	3
Turkey	-	-	1
U.S.S.R.	1	-	1
United Arab Republic	1	-	-
United Kingdom	8	3	31
United States	7	66	93
Yugoslavia	-	1	-
	133	182	227

APPENDIX 2.5)c)iv

NUMBER OF PROFESSIONAL PERSONNEL IN EACH
DEGREE LEVEL IN RELATION TO YEARS SINCE GRADUATION
AND TO LENGTH OF EMPLOYMENT WITH THE PRESENT ORGANIZATION

No. of Years Since Graduation	Degree Level and Numbers			No. of Years Employed with Organization	Degree Level and Numbers		
	Bachelor	Master	Doctor		Bachelor	Master	Doctor
0	9	5	4	0	9	9	9
1	17	14	11	1	31	40	37
2	7	17	16	2	15	32	45
3	10	15	9	3	10	8	11
4	4	9	11	4	7	7	7
5	3	7	12	5	3	4	7
6	1	8	14	6	1	7	8
7	1	5	7	7	3	6	10
8	3	7	6	8	4	11	7
9	1	8	10	9	2	4	5
10	2	4	4	10	2	2	6
11	3	3	11	11	3	3	7
12	7	6	11	12	2	2	6
13	1	2	7	13	1	2	2
14	2	5	7	14	-	1	3
15	3	3	11	15	6	4	8
16	3	11	9	16	3	5	7
17	4	4	8	17	2	2	4
18	6	16	14	18	2	15	9
19	11	9	8	19	5	8	9
20	5	6	4	20	3	1	3
21	2	2	1	21	1	2	2
22	3	1	3	22	5	1	2
23	-	1	4	23	3	-	3
24	1	4	2	24	2	-	1
25	-	-	1	25	1	-	1
26	1	1	1	26	1	-	-
27	2	2	2	27	-	2	3
28	2	2	7	28	-	1	3
29	1	1	1	29	-	-	-
30	2	-	-	30	-	1	1
31	-	-	1	31	-	-	-
32	3	1	2	32	3	-	-
33	3	-	1	33	1	-	-
34	1	2	-	34	-	1	-
35	1	-	2	35	-	-	-
36	3	-	2	36	-	-	-
37	1	1	-	37	-	1	-
38	1	-	3	38	2	-	1
39	1	-	-	39	-	-	-
40	1	-	-	40	-	-	-
41	-	-	-	41	-	-	-
42	1	-	-	42	-	-	-

APPENDIX 2.7)a)4

Contract Funds in Support of Intramural Research

Activity	Sector Awarded Contract, and Amount											
	Industry		University		Consultants		Provincial Agencies		Former Employees*		Total for Activity	
	1965-68	1968-69	1965-68	1968-69	1965-68	1968-69	1965-68	1968-69	1965-68	1968-69	1965-68	1968-69
Resource and Management Research	$29,950	$4,300	$3,550	-	$14,900	$5,000	$5,300	-	$2,200	-	$55,900	$9,300
Forest Protection	$31,200	$17,000	$5,200	-	-	-	$3,000	-	$2,400	-	$41,800	$17,000
Forest Products	$1,560	-	$4,050	-	-	-	-	$8,000	-	-	$5,610	$8,000
Forest Economics	-	-	-	$10,000	-	-	-	$7,000	-	-	-	$17,000
Application of Research Findings	-	-	-	-	$1,400	-	$1,400	-	-	-	$2,800	-
Totals	$62,710	$21,300	$12,800	$10,000	$16,300	$5,000	$9,700	$15,000	$4,600	-	$106,110	$51,300

* Contracts to complete reports on work undertaken before resignation

APPENDIX 2.8 (4)

CONFERENCES, WORKSHOPS, MEETINGS, SYMPOSIA, ETC.
ATTENDED BY PERSONNEL OF THE FORESTRY BRANCH

(a) Workshops, Councils, Symposia, etc.

Agricultural Meteorology Conference of the American Meteorology Society

Annual Symposium on Biomathematics and Computer Science

Canadian Forest Tree Improvement Committee

Canadian Joint Wood Chemistry Symposium

Canadian Pulp and Paper Association

(i) Logging Section

(ii) Fire Control Section

Central International Forest Insect and Disease Work Conference

Clinic on Library Application of Data Processing

Commonwealth Institute of Biological Control Insect Pathology Colloquium

Conference on Applied Meteorology

Conference on Artificial Regeneration, Ontario

Conference on Fire and Forest Meteorology

Council of Biology Editors

Federal Societies of Paint Technology

Fifteenth Professional Photographers Association of Canada Seminar

Forest Engineering Conference

Forest Microclimate Symposia

Forest Micrometeorology Symposium

Harvard Conference on Forest Production

Inter-mountain Forest Fire Research Conference

Lake States Biological Conference

Lake States Entomological Workshop

Lake States Forest Products Convention

Lake Superior Biological Conference

Montreal Special Libraries Association

Muskeg Research Conference

National Fire Prevention Association

National Soils Survey Committee

National Weed Committee

National Xmas Tree Growers Association

North American Forest Soils Conference

Northeastern Fire Control Compact

Northeastern Forest Disease Workshop

Northeastern Forest Fire Research Conference

Northeastern Forest Pest Council

Northeastern Forest Tree Improvement Conference

Northeastern Loggers Conference

Northeastern U.S. Forest Economics Association

Northwest Forest Soils Council

Sixth Cellulose Conference

Sixth Central States Forest Improvement Conference

Special Libraries Conference (Minneapolis)

Sugar Maple Conference

Tall Timbers Fire Ecology Conference

Tripartite Chemical Engineering Conference

Weekly Newspapers Association (Annual Meeting)

Western Dry Kiln Club Meetings

Western Fire-Weather Meteorologists Conference

Western Forest Disease Work Conference

Western Forest Insect Work Conference

Western Snow Conference

Western U.S. Forest Economics Association

(b) National Conferences

Acadian Entomological Society

Agricultural Institute of Canada (Soils Section)

Alberta Entomological Society

Alberta Phytopathological Society

Association Canadienne des bibliothecaires de langue française, Québec

Association Canadienne de la radio et de la television de langue française

Association canadienne-française pour l'Avancement des Sciences

Association des hebdomadaires de langue française

Association des Manufacturiers de bois de sciage du Québec, Québec

Atlantic Provinces Economic Council

Biological Council of Canada

B. C. Truck Loggers' Convention

Canadian Agricultural Economics Association

Canadian Association of Geographers

Canadian Association of Physicists

Canadian Botanical Society

Canadian Economics Association

Canadian Industrial Editors Association

Canadian Institute of Forestry (National and section meetings)

Canadian Library Association

Canadian Lumbermen's Association

Canadian Phytopathological Society

Canadian Political Science Association

Canadian Public Relations Society

Canadian Pulp and Paper Association

(i) Woodlands Section

(ii) Technical Section

Canadian Society of Microbiologists

Canadian Society of Plant Physiologists

Canadian Society of Soil Science

Chemical Institute of Canada

Engineering Institute of Canada

Entomological Society of British Columbia

Entomological Society of Canada

Entomological Society of Ontario

Entomological Society of Quebec

Genetics Society of Canada

Public Service Association, Ottawa

Quebec Lumber Manufacturers' Association

Quebec Society for Protection of Plants

Western Forest Genetics Association

(c) International Conferences

Air Pollution Control Association

American Association for the Advancement of Science

American Association for Conservation Information

American Chemical Society

American Congress of Surveys and Mapping

American Economics Association

American Federation of Information Processing Societies

American Management Association

American Phytopathology Society

American Society of Agricultural Engineers

American Society of Electrical Engineers

American Society of Microbiology

American Society of Photogrammetry

American Society of Plant Physiology

American Society of Protozoologists

American Society of Quality Control

American Society of Ventilating and Air Conditioning Engineers

American Statistical Association

American Wood Preservers Association

Association of Official Analytical Chemists

Biological Photographic Association

Biometrics Society of America

Commonwealth Agricultural Bureaux Conference

Commonwealth Forestry Conference

Eastern Regional Publisher Personnel Association

Economic Commission for Europe

Electron Microscope Society of America

Entomological Society of America

Federation of American Societies for Experimental Biology

Federation Internationale de Documentation

Federation of Societies for Paint Technology

First Canadian Conference on Micrometeorology

Food and Agriculture Organization (FAO)

(i) Biennial Conferences
Technical Committee on Forest and Forest Industries

(ii) International Poplar Commission

(iii) Advisory Committee of Experts on Forestry Education

(iv) Committee on Wood-Based Panel Products

(v) North American Forestry Commission

Working Groups on: Forest Insects and Diseases

Forest Fire Control

Wildlife and Outdoor Recreation

Forest Tree Improvement

(vi) FAO/IUFRO Committee on Bibliography and Terminology

(vii) World Forestry Congresses

Forest Products Research Society

International Agricultural Aviation Society

International Association of Scientific Hydrology

International Biological Program

International Conference on Biochemistry

International Conference of Data Processing

International Conference of Photobiology

International Congress of Entomology

International Congress of Photogrammetry

International Congress of Plant Pathology

International Congress of Soil Science

International Great Plains Conference of Entomologists

International Heat Transfer Conference

International Marketing Conference

International Plant Propagators Society

International Symposium on Chemistry

International Symposium on Ecosystems

International Symposium on Macromolecular Chemistry

International Symposium on Watersheds

International Union of Forest Research Organizations (various Sections and Working Groups)

Mycological Society of America

Northeastern Furniture Dimension Association

Organization for Economic Cooperation and Development

Rural Sociological Society of America

Society of American Foresters

Society of Experimental Stress Analysis

Society of Invertebrate Pathology

Special Libraries Association (International)

Technical Association of Pulp and Paper Industry

Tissue Culture Association

Western Forestry Conference

Western U.S. Forest Economics Association

World Meteorological Organization

(i) Commission for Agricultural Meteorology, Fourth Session

APPENDIX 2.9 (1)

SUB-ACTIVITIES OF SEVERAL OF THE MAJOR ACTIVITIES OF THE FORESTRY BRANCH

Activity 1. Resource and Management Research

Sub-Activity (a) - Land Classification

Research in land classification is directed toward attaining a better knowledge of the land resource to provide for optimum use and to relate this to information on tree biology that can be used in some practical manner in forest management. Classification of land according to its physical features and ability to produce forests is a prerequisite for long-term planning, both for forestry and associated multiple use. The work involves the initial classification of forestland in terms of physical and ecological characteristics, and will require knowledge in such disciplines as air photo interpretation with respect to surficial geology, soils, and vegetation types. There will also be special problems concerned with classification of currently non-productive bog land. In addition, there is a program in hydrology, which studies the effect of manipulating the tree cover on the quantity and quality of the water yielded by the forested area. This program is brought about through the coordination of research by specialists in hydrology, geomorphology, pedology, ecology, botany, meteorology, and silviculture.

Sub-Activity (b) - Forest Soils

2. Basic research in forest soils complements the work in land classification. Studies of soil chemistry, physics, fertility, genesis, microbiology, and pedology are undertaken to provide the knowledge necessary to predict and improve tree growth. Also, tree nutrition problems are a major concern in reforestation programs and the use of fertilizers provides one of the few proven means of increasing forest production. Preliminary work is being carried out on the study of chemical properties of soils to determine their long-term productivity, and on a study of nutrient uptake and cycling for various forest types. Also, investigations are underway on soil biology to determine the role of soil fauna in litter breakdown and on microbial response to insecticides.

Sub-Activity (c) - Inventory and Mensuration

3. Forest mensuration provides the information and techniques necessary to express the status and behaviour of trees and forests in quantitative terms. Research undertaken in this sub-activity covers the development of forest inventory and survey methods, including particularly the photogrammetric measurement and interpretation of aerial photographs for forestry purposes. Efficient methods of measuring the tree and stand size (volume, height, diameter, and area) are devised and tested. Methods of evaluating the growth and yield of forests over a range of conditions and long periods of time are required to provide data for the planning of forestry operations. Techniques are developed for organizing all relevant information for forest properties into efficient plans of management, including the regulation of the allowable cut to achieve management objectives. Also, mathematical models of forests are constructed to permit systems simulation for the development of efficient silvicultural and harvesting programs.

4. Much of this program is carried out in cooperation with other agencies. An example is the use of large-scale aerial photographs in conjunction with a radar altimeter, developed cooperatively with the National Research Council, to permit the measurement of tree size and other stand characteristics independently of ground control through accurate determination of photographic scale from the altimeter. Another major cooperative project is in logging research that will incorporate studies by economists, mechanical engineers, mensurationists, silviculturists, and others in the development of harvesting systems that will reduce wood costs at the mill.

Sub-Activity (d) - Silviculture

5. Silviculture is the theory and practice of controlling forest establishment, composition, and growth. Much of the control is exercised at the time of harvesting through modifications of cutting methods, seed bed preparation, and reforestation, but subsequent operations such as thinning, pruning, and improvement cuttings throughout the rotation influence growth and quality. The objective is to ensure future wood supplies at

minimum cost. The research programs are organized with no sharp dividing line between basic and applied studies, and these studies usually relate to problem solving in particular forest types or locations. Examples are problems in the spruce-fir forests of eastern Canada, the black spruce forests of northern Canada, the mixedwood stands in southern Quebec and the Maritimes, the tolerant hardwoods in southern Ontario, the white spruce-aspen stands of the prairies, Douglas fir in various mixtures at the west coast, the various mixtures of conifers in the interior of British Columbia, and pure pine stands or pine mixtures in different parts of Canada.

6. During the past ten years there has been a revolution in harvesting methods and an overall mechanization of forestry operations. Silviculture must now meld biological and ecological knowledge with new technological advances. Emphasis is placed on use of mechanization in afforesting and reforesting lands which fail to regenerate following fire or harvesting. This covers such subjects as container planting, aerial seeding by helicopter, mechanical scarification of soils, use of herbicides to control competing vegetation, the use of fire to prepare seed beds, as well as fertilization and drainage of wet sites.

7. This coordinated program requires the knowledge obtained from research in a wide number of specialities in soils, ecology, and biology.

Sub-Activity (e) - Tree Biology

8. A comprehensive program of forest research or forest management is dependent upon fundamental knowledge of the biological characteristics and basic behaviour of individual trees and tree species. The current program in this sub-activity embraces silvics, forest genetics and tree breeding, tree physiology, biochemistry, nutrition, and morphology.

9. Forest genetics and tree breeding research aim to produce genetically improved tree seed for use in reforestation programs. Investigations in silvics provide information on the response of tree species to environmental factors, such as light, temperature, and moisture. Research into root development and its relationship to stem and crown growth are also included.

10. Research in tree physiology, biochemistry, and morphology includes studies of the form and structure of trees and of their life processes, to

determine how the various processes can be controlled. Work in progress includes investigations of such processes as photosynthesis, respiration, nitrogen metabolism, nutrient cycling, and water economy in the trees, the development of hormones to regulate growth and flowering, etc.

Activity 2. Forest Protection

Sub-Activity (a) - Forest Fire

11. This sub-activity is broken into several projects that aim to solve the most pressing problems facing agencies responsible for detection, prevention, suppression and control of forest fires, as well as the use of fire as a management tool in Canada. Damage appraisal for forest fire losses is also included.

12. Rating and forecasting fire danger is dependent upon development of indexes of hazard and danger that permit a mathematical rating of the potential for ignition of forest fires, and the difficulty of suppressing fires underway. This requires research in a broad range of disciplines, such as meteorology, physics, chemistry, mathematics, and statistical sampling.

13. A major problem in forecasting fire damage and fire behaviour is based on the type of fuel available for burning. Research in fire behaviour and fuel-type classification involves studies on the size, arrangement and moisture content of the various types of fuels in forest stands and in the chemistry and physics of fires as related to forest fire intensity.

14. Much of the work in forest fire suppression involves research into the use of aircraft. Water discharge patterns for all water bombers commonly used in Canada are investigated and studies are underway to determine the relative efficiencies and optimum disposition of aircraft of different capacities. Research is also carried on in the use and development of fire fighting equipment, such as hand tools, power pumps, and forestry hose. Also, investigations are made of the use of foams, slurries, chemicals and wetting agents in suppressing fires.

15. The use of fire as a forest management tool is becoming more common in Canada, especially as a means of preparing seed beds for regenerating new forest stands and, also, for removing large quantities of slash that create a fire hazard.

16. A considerable amount of investigation has been made of different methods of fire detection and involves developing systematic means of locating fire towers, systems of using aircraft for forest fire detection and for combining their use with fire towers, use of infrared scanning devices and radio and, more recently, investigations are being developed on the use of satellites to detect forest fires. Studies have been made of different means of planning detection and suppression systems for forest fires on small and large areas. These are related to forest fire hazard and to projections of damage. A considerable amount of work has gone into the development of analytical techniques for forest fire appraisal.

Sub-Activity (b) - Insect and Disease Survey

17. The Forest Insect and Disease Survey is a coordinated program that operates continuously from seven regional establishments. Its primary purpose is the surveillance of all forestlands to detect and appraise insect and disease outbreaks and conduct an annual census of both native and accidentally introduced foreign pests. This Survey is supported by research in morphology and taxonomy of the various life stages of forest insects, and in mycology; development of sampling designs and techniques for biological assessment of populations of insects; and also the development of means for biologically assessing control programs. Other related studies include economic analysis of damage caused by insects and disease and cost-benefit analyses of operations aimed at reducing forest losses.

Sub-Activity (c) - Entomology

18. The research in entomology is largely concerned with specific regional problems but there are also two Institutes that are concerned with control tactics that involve the use of chemicals or disease organisms. Most forest trees are susceptible to attack by many kinds of insects, but the main emphasis of the research program is concerned with those tree species that are most vulnerable to attack and developing control measures where tree mortality is likely to exceed tolerable levels. As a consequence, predictions of changes in insect populations are required. This requires a considerable amount of research into the population dynamics of different species and involves studies in ecology, nutrition, meteorology, genetics,

physiology, predation, parasitism, insect pathology (mycology, bacteriology and virology), etc.

19. Approaches to control feature cultural, biological or chemical methods. Cultural control attempts to adjust planting or cutting practices with the view to reducing losses and is closely related to changes in environmental conditions or accessibility of food that can be brought about by silvicultural techniques. Biological control is concerned not only with the introduction and manipulation of parasites, predators, and pathogenic micro-organisms, but also the manipulation of hormones, insect sterilants, and attractants. Chemical control, especially the aerial application of chemical insecticides, has been widely used to date. It requires substantial research in developing means for dispersing the insecticide evenly and effectively, development of techniques for biologically assaying the results, as well as the development of techniques for following the path of the insecticide throughout the ecosystem and its affect upon other biological forms in the ecosystem.

Sub-Activity (d) - Forest Diseases

20. Tree diseases in Canada cause mortality to merchantable timber, destruction of wood in living trees, reduced growth of trees, and delay the natural restocking of forestlands, as well as reduce the value of wood products in storage or in use. The research program in diseases is directed toward the solution of the most serious disease problems and the development of means for their control. The program is designed to reduce losses to acceptable levels, either through adjustments in forest management practices, or directly through the application of chemicals and cultural procedures. The most important disease problems include decays, nursery diseases, dwarf mistletoes, root rots, cankers and die-backs, and foliage diseases. Research has shown how to correlate the amount of decay with tree age, diameter, external indicators, and other factors that provide methods of assessing decay as a general procedure in forest inventory methods. Other studies have made possible more effective utilization through the definition of priority cutting schedules in mature and overmature timber. Research on decay and deterioration of forest stands

injured or killed by insects, fire, wind, or some other cause has provided information that has made it possible to economically salvage such wood for industrial use.

21. Research on nursery diseases involves the treatment of seed and nursery soil with fungicides to reduce losses. In plantations, research is carried out on root rot, and control measures are being developed as a result of studies of the parasitism and epidemiology of the casual fungi in relation to the physiology and ecology of the trees. This program of research involved a coordinated study throughout the country in mycology, bacteriology, virology, nutrition, ecology, and physiology of the micro-organisms related to other research programs in the physiology and ecology of the host trees and to silvicultural techniques for control methods.

Activity 3. Forest Products

Sub-Activity (a) - Wood Products

22. This sub-activity is concerned with research in wood anatomy and the mechanical and physical properties of wood. This requires studies, under high magnification, of the fine structures of wood and of the cell wall properties of wood, and relating these micro-structures to strength properties of wood under various types of uses. Studies in physics relate the macro-structures of the wood to strength properties in use and also to treatment of the wood with various types of coatings or preservatives.

Sub-Activity (b) - Protection

23. This sub-activity is concerned with research into the development of techniques for protecting wood against fire, insects, stain, decay, and weathering. Chemical studies aim to formulate fire retardants, insecticides, and fungicides that, when applied to the wood, will inhibit losses or reduce them to a tolerable level. An important part of this research is the development of improved techniques for impregnating wood with preservatives. A considerable amount of research is done in the physics of fire in wooden structures in cooperation with the National Research Council. Techniques are developed to measure the rate of progress of deterioration or damage by these varying agencies. At the present time,

a very pressing problem is the development of techniques to control decay of wood chips stored in large volumes at pulp mills.

Sub-Activity (c) - Structural Applications

24. Research in this sub-activity studies the strength of different types of wooden structures with an aim to developing trusses, beams, roofs, and other types of structures that will carry the required load and use a minimum amount of wood. Much of the results of research into the physical properties of wood is tied into this program.

Sub-Activity (d) - Utilization

25. This sub-activity incorporates research in harvesting in the forest, sawmilling, veneering, seasoning, machining, and secondary conversion. A large number of individual projects in mechanical engineering, electrical engineering, physics, and related fields, is coordinated into the development of machines, such as winches, saws, shears, barkers, limbers, pruning tools, kilns, knives, lathes, and the many types of machines such as sanders and planes that are needed in breaking down wood into different sizes and in machining and finishing it for final use.

Sub-Activity (e) - Wood Chemistry

26. Many species of trees contain chemicals that prohibit the use of the wood for many purposes. For instance, cedars contain compounds that quickly corrode the vessels used in pulping and paper making. Chemical research identifies these compounds and develops techniques for removing them from the wood and permitting the use of cedar for pulp and paper. Many Canadian woods, as well as imported woods, are studied with respect to their chemical content and the effect of these chemicals on different wood processes and uses with an aim to identifying the harmful or undesirable ones and removing them or rendering them ineffective.

27. Research in chemistry also is directed toward understanding the chemistry of many of the so-called by-products of the tree, such as bark, needles, lignin, various extractives etc., and to identify the main chemical compounds that might be of economical importance. Also, attempts are made to reconstitute these wood by-products into other compounds or forms.

Sub-Activity (f) - Pulping

28. Since a very high proportion of the wood harvested in Canada is subjected to the pulping process, it is desirable to try to improve existing processes or develop new ones that would be more economical and probably provide new products. Other studies aim to develop processes that will permit use of damaged wood, wood now considered waste, and species of trees that are not now commonly used.

Sub-Activity (g) - Packaging

29. Studies in this sub-activity are mainly concerned with development of packages that will more effectively protect Canadian produce in shipment. Studies involve the design of new packages and techniques for testing them in use, and the development of pallets or other means of handling packaged goods when moved from one conveyor to another.

Sub-Activity (h) - Gluing

30. This sub-activity is concerned mainly with the gluing processes in the formation of plywood and other laminated structures. Chemical studies are used to test glues under the various conditions that the bonded wood may be subjected to in service. This is extended to development of techniques and machines for testing gluelines and for inspecting laminated products as they are manufactured. Such tests are based on studies in physics, especially ultrasonics.

Activity 6. Research Services

Sub-Activity (a) - Biometrics Services

31. This is the largest component of this activity and includes the Biometrics Research Services unit in Ottawa, and also statistical and biometrical staff of field establishments. The Biometrics Research Services unit provides research and scientific consulting services and data processing services to the Branch as a whole. Staff at field establishments partially serve immediate needs of regional research programs.

Sub-Activity (b) - Library Services

32. This includes the headquarters departmental library at Ottawa and librarian and secretarial staff serving individual libraries at other Branch establishments.

Sub-Activity (c) - Scientific Editing Services

33. The staff at Ottawa includes an Editorial Services unit providing final editorial processing for scientific and extension publications in English and French, and a French-English creative technical writing service. It also includes scientific editing staff serving the immediate needs at regional establishments.

Sub-Activity (d) - Photographic and Drafting Services

34. This includes staff of regional laboratories serving these functions. Requirements of the Forestry Branch are served also by the Department's Graphic Unit in Ottawa.

APPENDIX 2.9)2)a

CELLULAR PHYSIOLOGY AND BIOCHEMISTRY OF CONIFERS

The aim of this project is to describe the growth, survival, and response of coniferous trees to changing parameters of the environment in molecular terms and thereby recapitulate and control embryonic growth and speed up the evolution of forest trees under asceptic and precise conditions.

2. One research scientist and four technicians are employed on this research. Expenditures for the year 1967-68 were $12,526 for operation and maintenance and $22,654 for purchase of equipment.

3. New metabolic paths, unknown before, in higher plants were revealed with the use of radioactive isotopes. Components of these paths fluctuate remarkably in level with season and during the day in growing regions of the tree revealing the locus whereby environmental effects on growth and differentiation are mediated at the molecular level. Levels of these nitrogenous molecules are also responsive to changes in mineral nutrients and correlate with changes in climate. Some of these compounds resemble others possessing properties of pharmaceutical value and endowing organisms with resistance to radiation. Understanding of the role of nitrogen in metabolism has provided the basis for another highlight of economic importance.

4. Chemical methods were developed (a) to evaluate growth responses of conifers before visual symptoms appear, (b) to evaluate response of the spruce budworm to host species in a way that may be amenable to control the pest, and (c) to produce and grow single living cells of conifers for (1) vegetative reproduction of genetically-identical, living cells of conifers that show promise of organizing into embryos, (2) study of fermentation products of high plant cells, (3) development of an assay system for the response to tree tissue to chemical agents and radiation, and (4) provide a model of optimal tissue yield of organized versus unorganized or cancer-like growth.

Bibliographic citations - Can. J. Botany 46, 909-919, 921-928, 929-937, 417-428 (1968); 45, 695-710. J. Insect Physiol. 14 1485-1497 (1968), Plant Physiology Academic Press, New York, Vol. IVA 377-686 (1965).

APPENDIX 2.9)2)b

CHEMISTRY OF WESTERN RED CEDAR

In 1950, inability to utilize western red cedar was the largest problem of the B. C. forest industries. This was because of its decay resistance variability, paint staining characteristics, corrosiveness in kraft pulping, metal staining, etc., and practically nothing was known of its chemistry. It was evident that better utilization could not be made without a more complete understanding of the types and quantities of extractives present in this species.

2. A project was begun that has occupied one professional chemist and one support technician since its inception. Direct expenses of chemicals and glassware are estimated at $12,000.00. Cooperation has been maintained with the lumber, shingle and pulp industry and use made of their facilities as required.

3. Mill-run samples of cedar wood average 12% to 14% extraneous materials. Two main families of extractives, the thujaplicins (related to the terpenes of the conifers) and the polyphenolic lignins (related to the lignin of the tree) account for nearly all of these materials. Early studies resulted in a complete understanding of the two types of corrosion caused by these extractives to mild steel used in pulp digesters. This led to the development of adequate linings for kraft pulp digesters and, as a result, mills now use 30% western red cedar in their pulp chip furnish compared to a previous maximum of 3% to 5%.

4. By 1963, the chemistry of the major amount of the extractive components had been determined. A bulletin on the chemistry and utilization of western red cedar related basic research to practical problems encountered with this species and explained how to avoid problems in metal-staining, corrosion, decay variability, and paint bleed-through. In recent years, research has revealed several new lignin components, many of which are novel and at this time are contributions to chemotaxonomy, tree physiology and organic chemistry generally.

5. Of eighteen publications resulting from this work, the following are representative:

MacLean, Harold and J.A.F. Gardner. 1953. Heartwood Extractives in Digester Corrosion. Pulp and Paper Mag. Can.: 54(12), 125-130 (1953).

Gardner, J.A.F. 1963. The Chemistry and Utilization of Western Red Cedar. Department of Forestry publication No. 1023.

MacLean, Harold and B.F. MacDonald. 1967. Lignins of Western Red Cedar (Thujaplicata Donn). VII. Dihydroxythujaplicatin. Can. J. Chem 45:739-740.

APPENDIX 2.9)2)c

THE DYNAMICS OF EPIDEMIC SPRUCE BUDWORM POPULATIONS

Infestations of spruce budworm pose one of the most serious problems in the management of spruce and fir in eastern Canada. They occur periodically, usually when a cycle of weather favourable to the insect coincides with the existence of mature forests of spruce and fir. An infestation can cover literally tens of thousands of square miles of forest and destroy up to 60% to 70% of the merchantable timber.

2. Studies aimed at elucidating the factors regulating population fluctuation and the interrelationships between the insect and other elements of the forest ecosystem were initiated in New Brunswick in 1945. The first phase of the investigation was completed in 1963 with the publication of a comprehensive monograph, under the above title, dealing with research on epidemic populations during the severe infestation of the 1950's.

3. During the period 1946 to 1962, approximately 72 man-years of professional and 108 of support staff have been devoted to the project. The total cost was about $2,160,000. As many as 12 scientists have worked on the project during some years.

4. Federal staff conducted the actual research. Great material assistance, however, was given by the N.B. Department of Lands and Mines, Forest Protection Limited, and several pulp and paper companies, especially Fraser Companies, Limited, on whose limits much of the work was done.

5. Among the project's many significant contributions are: Sampling techniques for a biological assessment program of extensive aerial spraying operations in New Brunswick; 'life tables' and mathematical models as tools in entomological research and practice; a monograph now regarded internationally as a model of entomological research technique; and, most important, a firm basis on which to develop predictive models of the pest's behaviour in given forest types and clarification of the potentialities and limitations of cultural and chemical control methods.

6. The success of the control program in New Brunswick hinged directly on the scientific knowledge arising from this study and it was calculated to have had a value by 1960 of $70 million.

7. The most important of more than 40 publications is:

Morris, R. F. Editor. 1963. The dynamics of epidemic spruce budworm populations. Mem. ent. Soc. Can. 31. 332 pp.

APPENDIX 2.9)2)d

CRYPTOSPORIOPSIN - AN ANTIBIOTIC
PRODUCED BY CRYPTOSPORIOPSIS SP.,
A FUNGUS ISOLATED FROM YELLOW BIRCH

A fungus, *Cryptosporiopsis*, associated with decay in yellow birch, was found to inhibit greatly the growth of a wide variety of fungi *in vitro*. It was also found to inhibit the decay of both sterile blocks of yellow birch wood inoculated with a fungus prevalent in dead birch and unsterile peeled logs of balsam fir. Further studies showed that the fungus produced an antifungal agent in liquid media.

2. Since 1965, about 7 man-years each of professional and support staff have been devoted to the project, and the total cost has been approximately $210,000. Several agencies at Fredericton, N.B. have contributed to the project, namely, the Victoria Public Hospital, the N.B. Veterinary Laboratory, and especially the C.D.A. Agricultural Research Station. Assistance has also been received from Arthur D. Little, Inc., Cambridge, Mass., U.S.A., and several other research laboratories in forestry and agriculture.

3. Research revealed methods of isolating and purifying the antifungal compound, defining its antimicrobial spectrum, characterizing its physical and chemical functionality, and elucidating its chemical structure. In addition, preliminary tests using white rats were done on the antibiotic, which was named cryptosporiopsin, to assess its mammalian toxicity when administered orally. Work is currently being conducted on the laboratory synthesis of cryptosporiopsin and its derivatives are being tested for antifungal activity. Experiments are also being conducted using both the fungus and cryptosporiopsin to determine if either can control the decay of pulpwood chips in storage. The application of cryptosporiopsin in the control of late blight of potatoes is being studied. A patent is pending concerning the antibiotic and its uses.

4. There are four publications from this project, the most pertinent is:

Stillwell, M. A., F. A. Wood and G. M. Strunz. A broad-spectrum antibiotic produced by a species of *Cryptosporiopsis*. Submitted to Can. J. Microbiol.

APPENDIX 2.9)2).

BACILLUS THURINGIENSIS AS AN INSECTICIDE

The use of chemical poisons to control insects has led to many pollution problems and scientists have turned to the study of insect diseases that might be used to better advantage. Bacterial diseases of insects have been known many years, but it was not until 1954 that a member of the Insect Pathology Research Institute demonstrated that the protein of the inclusions of certain bacteria is toxic to harmful insects. About one and one-half man-years of scientist effort and an equal amount of sub-professional support have been applied more or less continuously on this problem at the Institute since 1950. Additional annual expenditures averaged about $1,500.

2. Close cooperation has been developed in various phases of the research with other establishments of the Forestry Branch, the Canada Department of Agriculture, Forest Protection Limited, Fredericton, N.B., and Shell Research Laboratories, Slough, England. The Institute program, directed chiefly to the solution of basic problems, has explained the mode of action of the toxin and developed significant contributions for producing, using and testing the organisms. Practical demonstrations have shown the definite potential for control of injurious insects and have stimulated development research on the part of industry. Conseqently, several brands of *Bacillus thuringiensis* preparation are now available commercially and extensively used for the protection of certain agricultural crops.

3. Bacterial insecticides have a particular advantage over chemicals in that the former are more selective against target insects and have no undesirable side effects. Although bacterial insecticides have been used effectively against agricultural insect pests, economical use has not been developed against forest insects.

4. Approximately fifty papers have been published by Institute staff on this subject, of which the most pertinent are:-

Heimpel, A. M. and T. A. Angus, 1960. Bacterial insecticides. Bacteriol. Rev. 24(3): 266-288.

Angus, T. A., 1968. The use of *B. thuringiensis* as a microbial insecticide. World Rev. of Pest Control 7(1): 11-26.

APPENDIX 2.9)2)f

DEVELOPMENT OF A LARGE-SCALE AERIAL PHOTOGRAPHY -- RADAR ALTIMETER SYSTEM OF FOREST AND LAND INVENTORIES

Millions of dollars are spent every year on inventories of Canada's forest and land resources. It has long been one of the goals of the Forestry Branch to increase the efficiency of these inventories.

2. In recent years a new system to revolutionize forest inventories has been developed to reduce expensive field work by relying upon low-level, large-scale (1:1000) aerial photographs. Detailed information is extracted from these photographs through a combination of photogrammetric procedures and statistical estimation.

3. Two research scientists and two technicians have been engaged on this project for the last three years; in addition approximately $12,000 has been spent by Forestry Branch on equipment development and testing. The Radio and Electrical Engineering Division of the National Research Council cooperated closely in this development and was responsible for developing the prototype.

4. Accomplishments to date are in two fields: 1) completion of research to establish the reliability with which detailed information, e.g. tree species, quality and size of individual trees, can be obtained from photographs; 2) the development of an airborne radar altimeter that has the unique characteristic of measuring flying height above ground precisely without being affected by intervening vegetation. This height may be automatically recorded on each photograph.

5. An inventory of forests in the Mackenzie River Delta has been completed by large-scale photography and the system will soon find its first major application in the forest inventory of Labrador. A commercial firm has been granted the license for manufacture of the radar altimeter and this instrument, with a unit cost of $20,000, gives indication of being a highly successful commercial development with an international market and applications reaching far outside the field of forestry.

Reference

Westby, R.L., A.H. Aldred and L. Sayn-Wittgenstein. 1968. The potential of large-scale air photographs and radar altimetry in land evaluation. Proc., C.S.I.R.O. Symposium on land evaluation, Canberra, Australia, 1968.

APPENDIX 2.9)2)g

NON-DESTRUCTIVE TESTING
OF CONSTRUCTION LUMBER

Because of the lack of means of evaluating the strength of individual components, most wood is used very inefficiently in construction and carries only a fraction of the load it is capable of supporting. This has added greatly to the cost of wood construction. The desire to increase the use of wood as a construction material led to initiation of a research program aimed at the development of non-destructive test methods for wood. The program required about 6.5 man-years of professional time and 5 man-years of assistance, and an expenditure of about $40,000 on research equipment and supplies.

2. A useful correlation between vibrational properties (dynamic modulus of elasticity) and strength was established through extensive studies with small clear specimens. After having established the necessary correlation between a measurable property and strength under ideal laboratory conditions and using small specimens, a means was developed for applying this principle to commercial sizes of timber. It employed photoelectric devices and electronic circuitry, including an analog computer. This equipment has the potential capability, with the addition of facilities for handling materials, of processing lumber at the rate of one piece per second.

3. In addition, these results have produced a new proposal for non-destructive testing of construction lumber, which places greater emphasis on the modulus of elasticity. Because this is being well received in Canada and other countries, it should materially improve the efficiency of utilization of construction lumber.

4. Of the several papers published on this subject, the following are pertinent:

1. Development of a vibration grader. Dept. of Forestry and Rural Development Publication No. 1208, 1967.

2. A new look at mechanical lumber grading. For. Prod. J. 1968 (in press).

APPENDIX 2.9)2)h

SIMULATION MODELS FOR TREE HARVESTING MACHINES

In eastern Canada recently, emphasis has been placed on reducing the cost of pulpwood at the mill. The area where greatest cost reduction can be achieved is in cutting the tree and extracting it to the roadside. To do this harvesting machines are being developed. These are large machines and their development from drawing board to production model is long and expensive. Frequently it is not possible to predict how the machine will operate in the forest until a prototype has been built. One way in which such information can be obtained while the machine is still on the drawing board is by simulation.

2. Knowing the basic operating characteristics of the machine and the structure of the stand, it is possible to construct a mathematical model to simulate the passage of a harvesting machine through a stand and to obtain estimates of productivity under different operating conditions. Models have been built for machines, such as the Beloit and Logging Research Associates Log-All, which are already in operation. In cooperation with the Royal College of Forestry, Stockholm, a model has been developed to simulate a proposed harvesting machine for thinning.

3. In the future the main objective of the project will be to simulate new machines in their early stages of development. This will provide the designers with vital operating data which can be used to modify the design before prototype construction and, hopefully, to reduce the number of prototype models that have to be built. As each prototype may cost $100,000 to build, the potential benefits to the manufacturer and to the forest industry are large.

4. One scientist has been employed on the project for the past two years. He will be assisted by a programmer in the future. The only major expense is computer time -- about $4,000 per year.

Reference

Newnham, R.M. 1967. A progress report on the simulation model for pulpwood harvesting machines. Dept. Forest and Rural Develop., Inf. Rep. FMR-X-6.

APPENDIX 2.9)2)i

FOREST FIRE HAZARD FORECASTING

Forest fire control is a major burden to provincial and industrial forest agencies. They need an objective measure of fire hazard to make decisions about staff and equipment allocations and forest closure appropriate to the actual danger of the fire. The Forestry Branch has developed a method of calculating forest fire hazard and constructed fire danger tables for all regions in Canada. A fire danger index can be readily calculated from a few weather measurements made at noon, but it is applicable only for the day in which it is calculated. Fire control agencies were anxious to know the next day's fire danger. Consequently, trials were started in 1963 to test the feasibility of issuing 24-hour local forecasts in the three Maritime Provinces and to provide 'terminal' weather forecasts to personnel engaged on active forest fires.

2. The system took two years to develop to an operational basis. About two man-years of professional and six of support staff were devoted to the experimental phase. The total cost was approximately $60,000.

3. The chief cooperator was the Meteorological Branch of the Department of Transport, but the provincial forest services and some of the larger pulp and paper companies also collaborated.

4. The three provinces were divided into 44 forecast areas and a system of ancillary weather stations was set up to supplement those of the Meteorological Branch and to ensure that there was at least one weather station in each area. A teletype writer system was installed to ensure that the weather data from the key stations reached the forecast office by the early afternoon. These are used in conjunction with the forecasts of the Maritimes Weather Office in Halifax to calculate the next day's danger forecast. This information is available to the forest services and the industry one to two hours before closing time, allowing them to formulate their presuppression plans. It is also available for radio and T.V. stations to inform their listeners in the early evening.

5. The system has been on an operational basis in the Maritimes since 1964. It was extended to Quebec in 1966. The system is being adapted to calculation by IBM computer and will eventually be extended to serve all of Canada.

APPENDIX 2.9)2)j

CONTROL OF DWARF MISTLETOE IN LODGEPOLE PINE STANDS

Dwarf mistletoe is a serious threat to growing lodgepole pine on economic rotations in many areas of Alberta and British Columbia. Because many mature stands are now seriously damaged and the ultimate productivity and quality of extensive areas of young stands will be impaired, early and sustained control action must be implemented against the disease.

2. From 1960 to the present, a total of 2.6 man-years (professional = 1.0, support = 1.6) and $22,260 (including salaries) have been expended on a survey to measure its effect on tree growth, its propensity to kill trees, and the development of control methods. Cooperation with the forest services of Alberta and British Columbia and with National Parks in Canada has been limited to experimental use of public lands. Consultations with the United States Forest Service respecting survey and appraisal methods have been regular and mutually profitable.

3. Combinations of aerial and ground surveys of variously aged pine stands in a range of forest sites and measurements of diseased and healthy trees show that the annual loss of pine growth in Alberta alone is 9 million cubic feet. An infection index having application to trees up to the presently accepted rotation age of 100 years was developed to permit the hazard rating of individual stands. Stands that have originated from seed trees in an infected overstorey are so seriously affected that they cannot be considered of commercial value.

4. Pilot-scale trials of silvicultural controls have been developed in cooperation with the provincial forest services, industrial companies, and the United States Forest Service, and some are proving successful.

5. Among publications that have been prepared, the following is most pertinent:

Baranyay, J.A. 1965. Growth impact and control of dwarf mistletoe in pine stands of Alberta. In Proc., 13th Western International Forest Disease Work Conference, pp 9-16.

APPENDIX 2.9)2)k

LABORATORY EVALUATION OF INSECTICIDES AGAINST FOREST INSECTS, WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF INSECTICIDE RESISTANCE

In the repeated use of insecticides against a large number of pests throughout the world, the development of insecticide resistance within the pest has nullified the continued use of an initially valuable chemical. This resistance to a specific insecticide is the consequence of selection pressure exerted by the repeated long-term use of a particular toxic chemical. After eight years of aerial spraying against the spruce budworm in New Brunswick it was evident that, for acceptable control, areas receiving dosages of DDT that initially had been effective had to be treated again the same year. The development of resistance seemed to be the most logical explanation for this phenomenon.

2. Development of resistance affects this control operation in two ways:

(1) Greater and greater dosages are required for control and these dosages, in turn, create greater hazards to other forest fauna, particularly aquatic fauna.

(2) As DDT resistance develops in an insect species, a similar cross resistance occurs to other related chlorinated hydrocarbon insecticides. If control is to be maintained, a different class of compounds must be substituted.

3. During a period of seven years, more than two man-years of professional and eight man-years of technician time were spent on this project. Other costs amounted to only $1,000 or $2,000 annually.

4. These studies were undertaken with the cooperation of the Regional Laboratory at Fredericton, which aided in the selection of areas and the collection of material. Aircraft and other facilities in New Brunswick were provided by Forest Protection Limited for the field testing of new insecticides.

5. The results of the DDT resistance studies and field testing of new insecticides provided the basis for the recommendation that Phosphamidon and Sumithion be substituted along all major salmon streams and eventually that DDT be totally replaced by these materials in large-scale operations in Ontario and Newfoundland in 1968. The program has since been expanded to include the possible development of resistance in other classes of insecticides and insect pests.

Randall, A. P. 1965. Evidence of DDT Resistance in Populations of Spruce Budworm, Choristoneura fumiferana (Clem.), from DDT-sprayed Areas of New Brunswick.

APPENDIX 2.9)2)1

THE USE OF CUTTING CLASSES IN FOREST SURVEYS

Cutting classes based on maturity and stand structural conditions are a well-established method of forest cover typing for purposes of management, inventory, and silviculture in Scandinavia. The method was adapted to Canadian conditions between 1955 and 1961 following a thorough comparison of it with conventional methods during inventory surveys on federal lands. It was found to be simpler to apply, more expressive for forest management purposes, well suited for photo-interpretation, and to reduce the cost of surveys.

2. The time spent on its development amounted to about one man-year for a scientist and two man-years for technical assistance. Costs for equipment and material were negligible.

3. The development work was done entirely within the Forestry Branch, at first in the Province of Quebec and later during the survey program of the northern Territories, Indian reserves, National Parks, and National Defence areas. When the method had been successfully demonstrated over a wide range of conditions, a Canadian firm of consultants adopted it for surveys overseas, and in 1963 the provincial forest services of Manitoba and Quebec accepted it. The U.S. Forest Service has been developing a similar system independently.

References

Anon. 1964. Dept. of Mines and National Resources, Manitoba, Annual Report p. 59.

Ray, R. G. 1951. Impressions of Norwegian and Danish forestry. For. Chron. 27(2): 96-121.

Ray, R. G. 1957. Patch cutting in second growth balsam fir at Matane, Quebec. Woodlands Section, CP and PA. W.S. Index No. 1697 (F-2-3/4).

Ray, R. G. 1964. Cutting classes in forest management. For. Chron. 40(4).

APPENDIX 2.9)2)m

DEVELOPMENT OF AN AIRBORNE INFRARED FOREST FIRE MAPPING AND DETECTION SYSTEM

Because of the increasing use of aircraft for forest fire detection, the Forest Fire Research Institute, in cooperation with Computing Devices of Canada Limited; Ontario Department of Lands and Forests; and Gatineau Forest Protective Association Limited for the Quebec Department of Lands and Forests, investigated the feasibility of detecting and mapping forest fires using airborne infrared equipment. This led to the development of a device that meets forestry requirements.

2. The Institute expended approximately one professional and two support man-years on the project and $9,300 on initial development and testing. Further financial support was provided by the Department of Industry under its PAIT program.

3. A light-weight airborne infrared scanner was designed and built by Computing Devices to meet fire control requirements as established by Branch staff and cooperators. The device was installed on light aircraft and flown on detection tests in Quebec and Ontario. The Quebec tests were concerned mainly with the detection of man-caused fires whereas the Ontario tests investigated the mapping of going fires and the detection of lightning fires. Following the tests, improvements were made to the scanner and the Department of Industry supported its further development. Continued field testing in Ontario followed and further modifications made to develop the final production model. A marketable item that will likely find widespread use in the United States and Canada and elsewhere is now available to forest fire protection agencies.

4. The following reports on this project are available:

Computing Devices of Canada Ltd. 1964. Fire detection trials. Ottawa, Ontario.

Williams, D. E. and P. H. Kourtz. 1965. An assessment of the airborne infrared fire detection system. Dept. of Forestry, Forest Fire Research Institute, Report No. FF-2.

Goodman, J. F. 1966. A report on the airborne fire detection system (AFDS-2) evaluation trials. Ont. Dept. of Lands and Forests, Forest Protection Branch.

APPENDIX 2.9)2)n

VENEER PRODUCTION INSTRUMENTATION

A survey of the techniques of veneer peeling and the quality of the product showed that veneer companies in British Columbia were suffering avoidable annual losses in the range of millions of dollars through the production of veneers of inferior quality. Many of the lathes observed showed considerable movement between components as a result of the continuous day-to-day wear on the bearings, feed screws, etc. Since veneer peeling is essentially a precision extrusion process, good results cannot be obtained on a machine that does not hold accurate settings, particularly the relationship between the knife and the bar that exerts pressure on the wood being cut.

2. A study of deficiencies in existing lathes showed where mechanical improvement and better maintenance could be of value, and also provided data on the relationship between amount of wear in the lathe and drop-off in veneer quality.

3. Staff of the Vancouver Forest Products Laboratory developed instruments that continuously measure movement between the knife and the roller-bar while the lathe is operating. These instruments utilize linear variable differential transformers monitored by solid-state oscillographs.

4. About two professional and eight technical support man-months and $12,000 was expended in designing and building these instruments, in making the necessary measurements and in interpreting the results.

5. The production from eight different industrial lathes has been measured at five plywood-producing mills. Two of the lathes measured were new and one was in a well-maintained condition. Each of the other five was overhauled on the basis of our findings and, in the four cases where veneer quality was subsequently measured, its economic value was increased considerably.

6. Two pertinent publications on veneer quality and instrumentation are:

Northcott, P.L., L.C. Palka, and W.V. Hancock. 1967. Peel Quality of Commercial Softwood Veneers. Department of Forestry and Rural Development, Internal Report VP-4.

Hancock, W.V., J.R.T. Hailey, and D.C. Walser. 1968. Potential for Improvement in Economic Return from Commercial Veneer Peeling. Department of Forestry and Rural Development (in press).

APPENDIX 2.9)2)o

A MOMENT CONNECTOR FOR GLUED-LAMINATED TIMBERS

The development of heavy glued-laminated timbers for use in the construction industry has created a demand for new types of connectors for joining members together. Heavy timbers were formerly joined with bolts used in conjunction with shear plates or split rings. This type of connector was strong enough but when it was loaded to work to capacity, deformation occurred which was undesirable with glued-laminated members. Consequently, the Vancouver Forest Products Laboratory initiated a program to investigate the merits of a nailed-plate connector employing specially designed high-strength steel nails.

2. The preliminary objectives of the program were to develop design criteria for the proposed connection by assessing the load-deformation characteristics, determining the effect of nail length, diameter spacing, and nail fixity between nail-head and plate. In addition, research was required on the design of the nail shank and nail point.

3. The resources of the Laboratory devoted to the program consisted of two man-years of professional time, three and one-half man-years of technical support, and approximately $1,500 spent on nails, plates and glued-laminated timbers. The Steel Company of Canada estimates that they spent $7,000 to devise suitable dies for the manufacture of the specially hardened nails. The research committee of the Canadian Institute of Timber Construction assisted in a consultative capacity as well as by supplying additional glued-laminated material.

4. A large glued-laminated structure has been built which has utilized the new type of connector throughout the structure with very considerable savings in labour and material costs. Proposed design criteria for the joint is undergoing preparation for inclusion in the second edition of CSA Standard 086 for Engineering Design in Timber.

Pertinent literature references are:

McGowan, W.M. 1966. A Nailed Plate Connector for Glued-Laminated Timbers A.S.T.M. J. of Mat.: 1(3), 509-535.

McGowan, W.M. 1967. Exploratory Tests of a Nailed Plate Connector for Glued-Laminated Construction. Dept. of Forestry Information Report VP-X-11.

APPENDIX 2.9)2)p

GROWING AND PLANTING
FOREST TREES IN CONTAINERS

Increases in Canada's forest harvest and decreases in mature stock necessitate prompt reforestation to maintain balanced cut with growth. Natural regeneration remains slow and uncertain; standard techniques of artificial reforestation are laborious, costly, and risky. Meeting the reforestation needs of the 1970's using conventional methods would mean major shifts of public and private resources. Alternatives would be to abandon sustained forest yield as a policy, or partially close forest industry.

2. The most promising recent development in reforestation technology has been the emergence of various systems of growing and planting trees in small containers. These systems offer substantial cost savings in seedling production and planting and may improve tree survival and growth performance in plantations.

3. In 1967, the Branch initiated a development project in the British Columbia Region to (a) compare the biological and economic effectiveness of various "container-tree" systems with standard nursery and planting techniques, and (b) refine the processes of establishing new forests with "container-trees".

4. Five professional and three technician man-years, plus $42,000, have been invested in this project. Under contract with the Branch, the British Columbia Research Council is developing an analytical model for evaluating nursery-planting systems. The University of British Columbia, the British Columbia Forest Service, and several forest companies in the province are also collaborating.

5. Trial plantations have begun and an automated-nursery pilot project was established, jointly with the B.C. Forest Service, at Duncan, B.C., in 1967-68.

6. Almost complete automation of growing, handling, and planting should be feasible while producing better seedlings with less risk of early crop failure. This will have a profound impact on future forest production while conserving scarce investment capital.

First Session—Twenty-eighth Parliament

1968

THE SENATE OF CANADA

PROCEEDINGS

OF THE

SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*

The Honourable DONALD CAMERON, *Vice-Chairman*

No. 16

WEDNESDAY, DECEMBER 11, 1968

WITNESSES:

Department of Energy, Mines and Resources: Dr. C. M. Isbister, Deputy *Minister;* J. P. Drolet, Assistant Deputy Minister (Mining); Dr. J. M. Harrison, Assistant Deputy Minister (Mines and Geosciences); Gordon MacNabb, Assistant Deputy Minister (Energy); J. MacNeill, Assistant Deputy Minister (Water) and Dr. A. T. Prince, Director, Inland Waters Branch.

APPENDIX:

14.—Brief submitted by the Department of Energy, Mines and Resources.

The Queen's Printer, Ottawa, 1969

29611—1

MEMBERS OF THE SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird	Hays	O'Leary (*Carleton*)
Belisle	Kinnear	Phillips (*Prince*)
Bourget	Lamontagne	Robichaud
Cameron	Lang	Sullivan
Desruisseaux	Leonard	Thompson
Grosart	MacKenzie	Yuzyk

PATRICK J. SAVOIE,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

WEDNESDAY, December 11th, 1968

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 3.30 p.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Bourget, Cameron, Grosart, Kinnear, Lang, Leonard, MacKenzie and Robichaud. (9)

Present but not of the Committee: The Honourable Senator Giguère. (1)

In attendance: Philip Pocock, Director of Research (Physical Science).

The following witnesses were heard:

DEPARTMENT OF ENERGY, MINES & RESOURCES:

Dr. C. M. Isbister, Deputy Minister;
J. P. Drolet, Assistant Deputy Minister (Mining);
Dr. J. M. Harrison, Assistant Deputy Minister (Mines and Geosciences);
Gordon MacNabb, Assistant Deputy Minister (Energy);
J. MacNeill, Assistant Deputy Minister (Water); and
Dr. A. T. Prince, Director, Inland Water Resources.

(*A curriculum vitae of each witness follows these Minutes.*)

The following is printed as Appendix No. 14:—Brief submitted by the Department of Energy, Mines & Resources.

At 6.00 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Isbister, Claude Malcolm B.A., Ph.D. Public Servant. University of Manitoba, B.A. 1934; Post-graduate study in Economics, University of Toronto, 1937; Harvard University, Ph.D. (Econ.) 1945; 1945-47, Asst. Dominion Statistician, Dominion Bureau of Statistics; 1947-49, Asst. Director, Economics Branch, Department of Reconstruction and Supply; 1949-57, Director, International Trade Relations Branch, Department of Trade and Commerce; 1957-58, Asst. Deputy Minister, Department of Trade and Commerce; 1958-63, Asst. Deputy Minister, Department of Finance; 1963-65, Deputy Minister, Department of Citizenship and Immigration; During 1966, Deputy Minister, former Department of Mines and Technical Surveys; Since 1966, Deputy Minister, Department of Energy, Mines and Resources.

Drolet, Jean-Paul. Born in Quebec City, P.Q. Attended Laval University where he obtained degrees of Bachelor of Arts and Bachelor of Applied Sciences in mining engineering. Studied mineral economics and mining engineering at Columbia University, New York, and was awarded a Master of Sciences degree. Mr. Drolet's career has, from the beginning, been closely linked with the mineral industry, particularly that of the province of Quebec: in the Abitibi, Témiscamingue and northern Quebec, and district of Ungava. Worked during some years as an engineer and geologist with the Quebec Department of Mines. Mr. Drolet has figured prominently in the developments surrounding Quebec iron ore industry with Quebec Cartier Mining Company where he was associated with prospecting, geological and exploration projects in North Saguenay County. Became Assistant to the President of Quebec Cartier Mining Company and elected director and member of its executive. He was also a director and member of the executive of Hart Jaune Power Company and Cartier Railway Company. He played a key role in the establishment and organization of the towns of Port-Cartier and Gagnon where he served on the Town Council during five years. Mr. Drolet was appointed Assistant Deputy Minister of the Department of Energy, Mines and Resources in 1963. He is currently a Vice-President of the Canadian Institute of Mining and Metallurgy and member of the following professional organizations: Corporation of Professional Engineers, P.Q.; Engineering Institute of Canada; American Institute of Mining and Metallurgy; Prospectors and Developers Association. He is also Chairman of the Canadian Permanent Committee on Geographical Names. In 1964, Mr. Drolet was awarded the Past Presidents Gold Medal, and in April 1968, was named a Distinguished Lecturer of the Canadian Institute of Mining and Metallurgy. Mr. Drolet is the author of numerous articles and technical papers in the field of mineral economics. He has published in Canada, United States and Europe. In 1964, he was a member of the Canadian Government's Committee on Trade and Tariff and member of the negotiating team that represented Canada at the GATT meeting of the Kennedy Round in Geneva. Mr. Drolet is also a director of a Crown Corporation, Canadian Patents and Development Limited. Former part-time lecturer in prospecting methods and mineral economics at Ecole Polytechnique and Laval University. Presently lecturer in the Department of Engineering and Mining

Geophysics, McGill University. Member of Cercle Universitaire, Ottawa, Seigniory Club, Montebello, P.Q.

Harrison, J. M. Dr. Harrison was born in Regina, Canada, in 1915. He received a B.Sc. degree from the University of Manitoba in 1935. Following two field seasons as an assistant on field parties of the Geological Survey of Canada and two years as a chemist, he returned to the University of Manitoba for graduate work, specializing in geology. He transferred to Queen's University where he obtained his M.A. degree in 1941 and his Ph.D. degree in 1943. He received Honorary Doctorate Degrees from the University of Manitoba in 1965, and from the Universities of Calgary, Queen's, and McMaster in 1967. Immediately following completion of his studies at Queen's, he joined the Geological Survey of Canada where he carried out investigations in various parts of the Precambrian Shield. In 1948 he was a Distinguished Lecturer for the American Association of Petroleum Geologists, and in 1949-50 was special lecturer in Precambrian Geology and Economic Geology at Queen's University, Canada. He became Chief of the Precambrian Division of the Geological Survey of Canada in 1955, and Director of the Survey in 1956. In June of 1964 he became Assistant Deputy Minister (Research) for the Department of Mines and Technical Surveys. Later, his title was changed to Assistant Deputy Minister (Mines & Geosciences) for the new Department of Energy, Mines and Resources. In 1961, Dr. Harrison became the first president of the newly-formed International Union of Geological Sciences, the latest member of the International Council of Scientific Unions family. In 1962 he was named to the then Bureau of the Council; in 1963 he was elected to the Executive Committee of the Council as first vice-president, and 1966-68 was its President. In 1966, Dr. Harrison was appointed a member of the Science Council of Canada. Dr. Harrison was the recipient of the Kemp Memorial Gold Medal from Columbia University in 1963 for his "outstanding contributions to geological science in the field of public service"; in April 1965, he was elected a Foreign Associate of the U.S. National Academy of Sciences; in March 1966, he was awarded the Gold Medal of the Professional Institute of the Public Service of Canada, and in April 1966 was awarded the Blaylock Medal of the Canadian Institute of Mining and Metallurgy. He is President-Elect, Canadian Institute of Mining and Metallurgy, Fellow and Past-President, Royal Society of Canada; Past-President, Geological Association of Canada; Fellow, Geological Society of America, and former member of Council; member, Society of Economic Geology, and former vice-president for North America; Fellow, Royal Canadian Geographical Society and a director; and a member of the Mineralogical Association of Canada and the Arctic Institute of North America.

MacNeill, J. W. Mr. MacNeill graduated from the University of Saskatchewan with degrees in Arts in 1949 and Engineering in 1958. In 1950 and 1951, he studied at the University of Stockholm, Sweden, where he specialized in Economics and Political Science. In 1958, he was employed by the Saskatchewan Department of Mineral Resources to organize and direct a Research and Statistics Branch in the Department. In 1959, he was engaged by the South Saskatchewan River Development Commission as Executive Director where he was responsible for the conception, development and execution of its program. When the Saskatchewan Water Resources Commission was established in 1964, he was appointed Vice Chairman and Executive Director. In 1965 he

was appointed Director of the Resource Development Branch in the Department of Energy, Mines and Resources. On January 1st, 1967 he was appointed Director of the Policy and Planning Branch of the Department, the position he now holds. Mr. MacNeill is a member of several professional societies, including the Engineering Institute of Canada and the Canadian Institute of Public Administration for which he was President of the Saskatchewan Regional Group. He has also published a number of papers in the field of administration and planning relating to natural resources.

MacNabb, Gordon Murray, Assistant Deputy Minister, Energy Development, Department of Energy, Mines and Resources. Born July 13, 1931 at Almonte, Ontario; Graduate of Carleton College in 1952 and of Queen's University in 1954 in Civil Engineering; Employed by the Water Resources Branch, Department of Northern Affairs and National Resources, Vancouver, between 1954 and 1957 on hydraulic studies relating to the power development possibilities of the Columbia River; Between 1957 and 1964 held progressively more responsible positions in Ottawa with the Water Resources Branch related to studies of international and federal-provincial water problems, particularly those dealing with hydro-electric possibilities. He was responsible for continuing studies relating to the Columbia River Treaty and was senior engineering adviser to the Government of Canada during international negotiations on the Columbia River Treaty and during the review of that Treaty by the Standing Committee on External Affairs; In 1964 he was appointed Chairman of the Canadian Section, Columbia River Treaty Permanent Engineering Board, a four-man international board responsible for ensuring that the objectives of the Columbia River Treaty and associated documents are fulfilled; In July 1967 he was appointed to his present position which is a senior policy advisory position concerning the development and utilization of the energy resources of Canada; He is a Registered Professional Engineer in the Province of Ontario and a number of engineering and technical associations.

Prince, Dr. A. T., Director, Inland Waters Branch, Department of Energy, Mines and Resources; Date of Birth, February 15, 1915; Place of Birth, Toronto, Ontario, Canada; Marital Status, Married—2 children; Education, BA, 1937 Chemistry, Mineralogy, Geology, University of Toronto; MA, 1938 Mineralogy, University of Toronto; PhD, 1941 Experimental Petrology, University of Chicago; Employment, 1940-50, With Division of Chemistry, National Research Council, Ottawa and affiliated industries, seconded from the Army, for research and development work on high temperature and other strategic materials; 1945, Lecturer, Department of Geology at University of Manitoba; 1946—present, With Department of Mines and Technical Surveys, now Department of Energy, Mines and Resources; 1946, Head of Ceramics Section; 1950, Head of Physics and Crystal Chemistry Section; 1959, Chief of Mineral Sciences Division; 1965, Director, Water Research Branch; 1967, Director, Inland Waters Branch; Professional Societies, Fellow, Chemical Institute of Canada; Fellow, Mineralogical Society of America; Fellow, American Ceramic Society; Member, Canadian Institute of Mining and Metallurgy; Member, Association of Professional Engineers (Province of Ontario); Member, Canadian National Committee for the International Hydrological Decade; Member, American Water Works Association; Member, Associate Committee on Water Pollution Research (National Research Council); Member, International Association on Water Pollution Research. Throughout his career, Dr. Prince

has been involved in bridging the gap between the academic earth sciences and their application to problems in engineering and technology. His early interests in geological research on igneous rocks led to applications in the field of ceramics and refractories to meet a broad range of industrial uses. An interesting development resulting from the work of one of his research teams was the finding of a chemical process and high temperature sintering technique which is currently in use for the preparation of uranium oxide fuel elements for today's atomic power reactors. With the growing urgency of problems arising in the field of water pollution and water resource development, Dr. Prince, in 1965 was asked by his department to head up a new Water Research Branch as Director and again to serve in the role of coordinating and directing the earth science aspects of the subject toward the solution of problems of a practical nature. On April 1, 1967 his duties were greatly expanded when the former Water Resources Branch of the Department of Northern Affairs and National Resources, a large engineering unit, was combined with the Water Research Branch. As Director of the combined organization, now called the Inland Waters Branch, Dr. Prince is responsible for the management of the largest federal government agency concerned with our freshwater resources. The Inland Waters Branch has a staff of about 840, has its headquarters in Ottawa and has more than 30 units located in other centres throughout Canada.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Wednesday, December 11, 1968

The Special Committee of the Senate on Science Policy met this day at 3.30 p.m.

Senator Maurice Lamontagne (*Chairman*) in the Chair.

The Chairman: Honourable senators, we are pleased, I am sure, to have with us this afternoon the representatives of the Department of Energy, Mines and Resources. On my right is Dr. C. M. Isbister, Deputy Minister, with whom I attended Harvard quite a number of years ago.

On my left is Mr. Jean Paul Drolet, Assistant Deputy Minister (Mineral Development). On my extreme right is Dr. J. M. Harrison, Assistant Deputy Minister (Mines and Geosciences). On my left is Mr. J. MacNeill, Acting Assistant Deputy Minister (Water), and Mr. Gordon MacNabb, Assistant Deputy Minister (Energy).

Mr. Claude Isbister will make an opening statement, and then we will proceed to the question period.

Dr. C. M. Isbister (Deputy Minister, Department of Energy, Mines and Resources): Thank you, Mr. Chairman. Honourable senators, I would like to start by giving tribute to the two officials of my department who were mainly responsible for the preparation of the substantial brief that has been distributed to you. This brief in fact represents quite a lot of work on the part of a number of people in all the relevant areas of our department, but two in particular, Dr. K. W. Downes and Dr. L. A. E. Doe, are responsible for it, not me. I would like to acknowledge this at the very beginning. The thought and efforts of many of us have been poured into it, but the rest of us know the burden that they carried.

I will now make a formal statement for the record.

Honourable senators, I should like to express appreciation for the opportunity to put before you this document that presents activities of the Department of Energy, Mines and Resources which depend upon its scientific and technical competence. Our Department takes pride in what the Department is accomplishing and we expect that our future work will be even more important. In these comments, I shall amplify certain of the concepts expressed in the brief and attempt to offer rationale.

In a sense the Department of Energy, Mines and Resources is one of the newest in government, having been created by Government Bill No. C-178 on October 1, 1966. In another sense it is the very oldest: on the 10th of September, 1841, the first united Parliament of the Province of Canada resolved "that a sum not exceeding 1,500 pounds sterling be granted to Her Majesty to defray the probable expense in causing a Geological Survey of the Province to be made". I might mention that those were pounds sterling of that day, I's sure, but even so the Geological Survey was begun in 1842, has continued to this day(an is the oldest scientific agency in the Government of Canada. It is 25 years older than Confederation itself. One is left to wonder if the legislators of that distant day really thought that a Geological Survey of Canada could be made for the sum of $1,500 pounds but it was a good try and a good beginning.

After Confederation, the Geological Survey became, in effect, a Department of Government responsible directly to a Minister and continued as such until 1907. At that time, the Mines Branch was established, and the two branches were combined into a Department of Mines. Since then the Department has expanded in its total responsibility, organization, and has had a succession of names. Various components, each with its long history

and traditions, have been combined from time to time and the latest creation is the Department of Energy, Mines and Resources. I mention this growth by accretion to point out a factor that I think is unique to this Department. At least four of the different branches have a long history, along with their own traditions and specialties. Their tendency has sometimes been to consider the Department and quite often the deputy minister simply an administrative inconvenience to their work.

Only in the last few years has there been a noticeable tendency for the branches to work together as a Department rather than as separate units. Various steps have been taken to this end. The program of five-year planning, recently instituted in the Government service, facilitates the appraisal of individual proposals within a comprehensive Departmental framework. This enables each branch to see what the others are planning for the long-term, and makes for more intelligent discussion at departmental meetings. The establishment of new branches also has its levelling influence. For example, the Inland Waters Branch in the new Department was created from components of four branches within the former Department, plus a major component from the Department of Northern Affairs and National Resources.

Administrative structures and practices are important but the Department depends ultimately on the ability and the motivation of its personnel. In these our Department is strong and this strength makes me optimistic. On a personal note, a Deputy Minister faces various demands on time and energy but the key to good administration is to get good, strong people appointed to the important positions, to work with them and support them.

Most activities undertaken in the Department are directly concerned with the development of resources of the country. These have a direct and important effect on aspects of the economy. It is safe to assert that the programs of nergy, Mines and Resources provide an earlier and larger return than any others supported by the Government. Resource-based industries are still at the heart of Canada's dynamic growth and the key to the future. These are the industries where we have the highest economic productivity and the greatest export earnings. Our geoscientific programs, both "wet" and "dry", are the essential foundation of natural resource development.

The control surveys and mapping carried out by our Surveys and Mapping Branch are fundamental for the development of the country as a whole. The investigations being carried out by the Inland Waters Branch are designed to meet an urgent need for knowledge about water pollution and its abatement; the Mines Branch addresses itself to problems of mining and mineral processing essential to the further growth of minerals industries; the Marine Sciences Branch is carrying out studies today that will enable the mineral and petroleum industries to explore more intelligently to-morrow the continental shelves and ocean bottoms; the Geological Survey is, in effect, the exploration arm for Government on the mineral wealth of the land; the Observatories Branch provides data on problems of defence, mineral exploration, and earthquake prediction; and our economic units study the trends and development of resources to provide guidance for the work of the Department as well as information to the Ministers of Government. All are engaged on long-term studies as well, studies that will pay off many years later.

The Department of Energy, Mines and Resources is mission oriented, not to a single mission but to several, and these are set out in the enabling legislation. Our scientific work is planned and directed to achieve these missions. It is this point of view that has been followed throughout this report. It applies whether we are dealing with astronomy, or investigating procedures to help abate pollution of our rivers and lakes; whether we are studying the characteristics of layering in the Atlantic Ocean, or attempting to develop an alloy that will be stronger and safer for aircraft undercarriages. We have been assigned missions that depend on science and research to achieve the desired goals. In this sense, our Department is engaged in applied research—we are attempting to reach specified goals. First class basic research is by no means excluded from our interests and purposes. In many instances, fundamental data have to be determined before the goal can be reached. Research might be of the "purest" in the mind of the individual who conceived it, but supported by his superiors because it will provide data to be applied to the mission. Perhaps it is worthwhile to give an example.

The bedrock of Canada is composed of many different kinds of rocks, some of which are distinctive and their origins difficult to explain. A scientist of the Geological Survey

may very well be intrigued by the characteristics peculiar to one of these rocks, think he has some clues that would be useful in determining the origin of the rock and explain its characteristics, and put up a first class proposal to carry out such a study. So far as he is concerned, this is curiosity-directed enthusiasm in advancing the frontiers of knowledge. It is basic research. His chief, however, might recognize that these fundamental studies could provide insight into ore deposits that may be associated with this kind of rock. When submitting the proposal, the chief would probably emphasize that the work is important because of information it could potentially provide for explaining associated valuable minerals, and thereby enable us to prospect more intelligently for those minerals. Assuming the project were approved, the scientist would regard his activities as basic or fundamental research; his manager would regard them as applied research; but in any event they are certainly mission-oriented. If such a project were initiated at a university, supported by grants-in-aid from our Department, it would be classified as basic or fundamental research.

In the context of the mission, probably the nearest thing we have to curiosity-directed research is that undertaken in the Observatories Branch, and especially in the field of radio and optical astronomy. No attempt is made to justify this on the basis of utility, but it is important for understanding the universe of which our earth is a part and, therefore, of understanding better the earth itself. In the long run, this research will undoubtedly lead to information, and eventually to concepts; that will enable us to make better use of this earth on which we live. Moreover, the studies of our universe have, in this generation, made it possible for manned-space flights, aid who knows what values will eventually come from these activities. Even astronomy turns out to be useful. Questions could be raised as to the advisability of carrying out such esoteric research in a Government department—indeed the Chairman of the Science Council has specifically questioned this point before this Committee. My own feeling is that the matter of jurisdiction is not terribly important, so long as the funding is provided and other astronomers have access to the instruments.

As a Government department we have priorities and programs. There is, however, an important complicating factor, and that is the individual scientific brain which happens to be available at a given time. Departments should be opportunistic and take advantage of particular strengths and skills that are available to them. Without first class scientists and engineers, we cannot possibly do our job, and it is sometimes worthwhile making adjustments in programs to take advantage of unique opportunities. A scientist may show unusual qualifications to carry out a study that does not have as high a priority as some others —one that normally would not be undertaken perhaps for several years. However, because the scientist is first class, has a well thought-out scheme with good possibilities, it would be unwise to keep him on what he would think of as routine work. Assuming his project is mission-oriented or applied, and probably costly, the only place it can be undertaken is in Government; failure to support him would almost certainly result in the loss of important scientific competence to Canada. Our budgets do not provide for as much flexibility of programs in this sense as our scientific directors wish, but we do our best to balance these important considerations against others.

In the general view, we see fairly substantial increases in the future in the scientific activities of the Department of Energy, Mines and Resources. Similarly, of course, other agencies, industries, and the universities that are interested in the topic of renewable and non-renewable resources will necessarily expand. We do not anticipate, in the long run, serious difficulties in recruiting the right people, nor do we foresee a surplus of geo-scientists and engineers. At least ten years ago, we began to hear of an impending over-supply of earth scientists. So far there is no evidence of an oversupply. Nevertheless, there may be an imbalance in the kinds of scientists and engineers that are turned out by the universities. Such imbalances are adjusted rather quickly, usually at the graduate schools or in the final year of university. If the students at the universities learn that there are few jobs for earth scientists, for example, some of those who were planning on majoring in that specialty will change to another. Palaeontologists will probably switch to biology if the job prospects are better in that field, and so on. It is impressive too, to note how specializations change after graduation, depending on the challenges put to the well-trained scientist.

We are disturbed by a tendency that we have seen exemplified, especially in one particular field. The Canada Centre for Inland Waters was established at Burlington, Ontario, for a variety of reasons having to do with the study of our inland waters, but also because it was within 50 miles of eight universities. All these universities are interested in, and appear to be planning to become specialists in water research, and not only specialists in water research, but Great Lakes waters. We welcome expressions of interest from the universities, and indeed are providing facilities for them at the Canada Centre for Inland Waters. Moreover, under the sponsorship of the Associated Colleges and Universities of Canada, a working group has been established to help guide the policies of research at the Centre. Nevertheless, it seems to us to be unwise and even dangerous for eight universities in one small area to attempt to become specialists in research on water. The money for research will almost inevitably be spread so thin that we cannot see how centres of excellence can be produced. Moreover, much of the research on the Great Lakes will depend on the availability of ship-time. Adequate ship-time for such a large number would almost certainly be out of the question. The solution to this problem must be found by the universities themselves and we are confident they are in the process of doing this.

There is a great deal of interest now in achieving the optimum balance between Government and universities and between basic and applied research. There is increasing recognition of the importance of approaching many fields of research on an interdisciplinary basis. Our Department has quietly provided constructive leadership in these matters for a long time. We have developed research in Ottawa and in our regional research stations on an interdisciplinary basis, with a full-fledged effort to relate programs to the needs and interests of universities in a flexible and adoptable fashion. I suppose our Mines Branch has been taking this approach to research for longer than anyone else. Current examples are to be found in our regional institutes at Bedford, Nova Scotia, dealing with oceanography, at Burlington, Ontario, dealing with Great Lakes pollution and at Calgary, dealing with sedimentary geology.

It is probably worthwhile to explain our approach to interdisciplinary research here by using the Canada Centre for Inland Waters as an example. I want to emphasize, however, that this is not an unusual example but simply that it is our newest research centre in a field that, for the first time, is becoming one of major importance in Canada. Our Mines Branch could be considered as a major centre of materials research because it studies all aspects of metals and minerals and their utility from the time they are broken up underground to the time they are put to use. It employs representatives of just about every kind of physical scientist, and even some biological scientists, all working together to produce and use metals most effectively. The Geological Survey employs large numbers of geologists, but also employs many geophysicists, geochemists, biologists, paleontologists, geographers, mathematicians, chemists, physicists, and so fourth. This I think is the reason they got an economist as deputy minister. Our Marine Sciences Branch depends on interdisciplinary studies, and has perhaps gone farther than some of the older branches by including scientific activities and representatives of other Government agencies. The efficient use of expensive ships makes such cooperation mandatory.

At the Canada Centre for Inland Waters, formal involvement at the planning stage is being invited from numerous agencies. An advisory committee is being formed and will be charged with providing advice on the operations and activities of the Centre. This committee will include representatives from other Government departments, from universities, and from industry. Facilities are being provided for other agencies and for the university community in the establishment itself. Ship-time will be allocated on the basis of the defined research program, and the Centre as a whole is being planned as an interdisciplinary, inter-agency research centre. The professional staff will include chemists, physicists, geologists, geophysicists, biologists, social scientists, engineers, and hydrologists. This is the procedure we think ought to be followed by Government laboratories wherever possible.

We hope that this close association of the universities with laboratories of the Department will result in more graduate students carrying out research in Government laboratories for credit towards their advanced degrees. Encouraging trends along this line are already apparent at the Bedford Institute

near Halifax, a trend we would endorse for other parts of Canada. Field projects in the earth sciences under the sponsorship of the Department have been accepted by some universities for about 50 years, but laboratory studies have been slower in gaining acceptance. We realize that universities must monitor the research but our engineers and scientists have worldwide reputations in their specialties and would be pleased to assist in developing graduate research programs.

We have attempted to respond to the guideline as applied to research in the natural sciences. However, scientific research is not, and should not, be limitd to the natural sciences, and the scientific work of our Department includes many socio-economic studies—the effects of water diversions on the life of communities, development of mineral resources and effects on the economy, the cost of pollution abatement as it will affect communities, and so forth. It is apparent that the needs for research in the resource sciences will, to some degree at least, be governed by the socio-economic factors that prevail in the country or in regions of it. One of the reasons for creating the Department of Energy, Mines and Resources was to provide the Government with the competence to develop long-range plans designed to meet national goals for the utilization of its natural resources, and to have within it the scientific and technical components that could carry out, sponsor and coordinate research designed to achieve those goals. Thus the scientific activities would be directly related to the needs of the nation.

It is worth emphasizing that all these plans must be long-range, if only because of the difficulties in turning scientific programs on and off. Departments such as ours need to plan on a reasonably even basis, otherwise the phasing in and out of research programs can be much too abrupt to be economical. Specialists who have been engaged to undertake studies in a particular field, and perhaps a fairly narrow field, cannot quickly develop skills in other areas, and their new assignment may make it difficult for them to work efficiently. Graduate students who have been encouraged to undertake research programs of interest to the Department, on the understanding that successful completion of these programs will probably mean employment, often leave the country when, owing to an unexpected cutback in funds, they cannot be offered employment.

We are responsible to taxpayers and to the scientific community to expend in the best way the resources put at our disposal. Perhaps the most important quality to develop in a big contemporary organization is the willingness to be constantly in a state of change and adaptation. Our Department is very dynamic and we must struggle to keep it so. Those of us in senior administrative positions must never grow comfortable—and there is little danger of this as far as we can see.

How do we eliminate old programs of diminishing utility? One method of reducing some of the difficulties woul be to make possible more freedom of movement between the Government and outside agencies, agencies both academic and industrial, and even within the Government itself. We believe too many people get locked into particular occupations, not only in our Department but in general. Some people dislike of course, major disruptions in their way of life and there is a tendency for administration to consider it a reflection on them if people transfer from one unit to another. Nevertheless, there needs to be more exchange between agencies such as ours and, say, the National Research Council, Surely there should be many more long-term secondments between Government agencies. We consider this question of transferability to be one that is well engaging the attention of Government planners. At present, we can send scientists abroad on technical aid missions more easily than we can exchange them among governmental and private agencies.

Another procedure which might help agencies to modify their programs more easily would be early retirement without serious loss of pension for those individuals who are at a "dead end" either because of the termination of a program, or because of their own inability to fit in with the changed plans of the agency. I should add here parenthetically that I do not think I am talking about a very large number or fraction of such individuals. There are some individuals who have been good producers but tend to carry on in a backwater until they can receive the full benefits of their pension. It would cost the Government relatively little and would result in greatly increased efficiency if such men were encouraged to retire from the Government at ages between 50 and 60. Many of them could provide excellent service to industry, to university and, even occasionally under contract to Government.

One of the factors that makes the efficient employment of scientific and technical personnel unnecessarily difficult in the Government departments is the unfortunate distinction between the so-called exempt agencies and the departments. It is worth pointing out that the employment and pormotional procedures established for such agencies as the National Research Council, Fisheries Research Board, and others, were planned in order to give them the flexibility required by a scientific agency. Scientific and technical departments such as ours should surely be permitted the same flexibility. For example, a departmental employee, if taken on on a continuing position, must be certified either as fit or unfit to continue at the end of one year. The exempt agencies can employ for renewable term. Freedom for classification of staff officers in the exempt agencies makes such appointments much more attractive there than in departments. Rules established to apply to the great bulk of the public service are not necessarily good for the few employers of scientists, a fact that was recognized when the exempt agencies were established. Departments could better serve the public if permitted the same freedoms.

As a mission-oriented agency, it might be difficult to contract substantial amounts of our research to universities. Much of our research depends on data which we as a Government agency are required to collect by regular repeated surveys, automatic recording devices, and the like. This kind of activity is not suitable to the academic environment. Experience has shown that an agency limited to the collection of data, without the opportunity to develop these data into useful concepts and programs, provides nothing to attract or challenge good intellects. The efficiency of the organization and the quality of its work therefore tends to deteriorate. If, therefore, the Departments is to continue effectively its role as a monitor and data collection agency, it must carry out research. Even so, it seems to us that there are more possibilities to contract research to universities than this Department has traditionally used, a factor that has been receiving more consideration in the last few years.

It is possible that considerably more scientific data-collecting could be contracted to industry than has been done in the past, even though our Department has probably been a national leader in this field—for example, the federal-provincial aeromagnetic surveys that are carried out entirely by industrial organizations.

Departments such as ours could make more use of development contracts to produce instruments, plans, and working procedures from ideas developed during research programs. The Science Council, for example, has emphasized the need for more R & D capability in our industries, and utilization of development contracts is an important method of ensuring the necessary skills as well as producing the "hardware" and the procedures. Government, however, must be prepared to accept the costly failures as well as the successes.

By science policy we mean the policy that determines the purposes for which science is used. Obviously, it should be used and developed to achieve national goals. We have spoken of it mainly in the context of Government, but have included some comments on the relationships between Government, industry, and universities. The question then outstanding is how much we should spend on science—especially the natural sciences. We have no easy answers. All the evidence that has so far been gathered points to the fact that the development side of R & D is the component in Canada that has not been pushed as it has in other countries. It is also the more expensive component, of R & D and, from present information, there can be little doubt that it should be increased substantially, if Canadian industry is to advance as it should. Probably also we will have to make much harder choices between the research projects to be undertaken. Rather than suggest a specific allocation of money to science—for example, 2 per cent or 3 per cent of GNP—we should determine what we need and do our best to meet the requirements. In my view our efforts are at too low a level by every relevant criterion. At present, our Department is indefinitely postponing what appear to us to be important programs pertaining to resource development, water management and pollution.

I would like to make some personal comments on the scientific community now and for the future. In the past, many scientists and engineers, have rejected responsibility for the consequence of their research. Moreover, they have generally rejected suggestions that they should work in fields other than those in which they were trained. Even

in the administration of science, they have tended to stay within their own general fields of competence. It seems to me now, however, that scientists are becoming more interested in the broader picture. They are interested in learning about the place of science in the world at large, so that they themselves can judge how better to use science. The interest shown in our Department, for example, by scientists and engineers in the Career Assignment Program of the Public Service suggests to me that the scientific and engineering community is attempting to obtain a broader base, and to use scientific and engineering skills as a means of becoming better administrators and policy advisors.

The shoe goes on the other foot as well. Science today is an integral part of modern life and of modern education. Surely people being educated to live in a world dominated by science and technology should be educated in science as a preparation for life in general.

This leads me, Honourable Senators, to my final point, and one that is strongly supported by senior officials of this Department. Because scientific research is essential to fulfill this Department's mission, we think it most undesirable for the research to be under the control of some other department. For this reason we do not see the advisability of a single ministry for science. Perhaps such a ministry would have been practicable a few decades ago, but scientific research pertains to every aspect of life and, in Government, surely cannot be hived off in one department. The Government must of course make decisions about whether to support general areas of scientific research, and the scale of its support. Essentially these decisions are of a financial nature, or one might prefer to think of them as involving the allocation of resources to areas of scientific research. This is perhaps the proper function of a ministry. It is to be hoped that the Science Council, which is still very new, will become increasingly competent to advise on these large and important matters.

Data, information, and suggestions from the scientific departments would be important contributions to such recommendations. Their contribution would be made in the light of the departmental missions, which in turn are dependent on national goals. But the departments, if they are to be effective, surely must be responsible for the direction and substance of their scientific research.

The Chairman: Thank you, Dr. Isbister. We have only about an hour and a half, and I am sure that we all have many questions to ask. Therefore, we should use this time as effectively as possible, otherwise our guests of today will have to return at some future date.

I will recognize successively Senator Lang first, Senator Grosart, Senator Kinnear and Senator Cameron.

Senator Lang: Mr. Chairman, I would first like to thank Dr. Isbister for his presentation and to congratulate the officials of the department on the preparation of the brief which they have given to this Committee.

It is refreshing to me to see a positive assertion of ideas that are basic to the considerations of this Committee and to see them so ably argued. Whether we will in our final deliberations concur with those conclusions or not I am sure none of us know, but we do appreciate the positive nature of both your presentation, Dr. Isbister, and those made by the departmental officials in the brief.

I would assume from the general tenor of the brief that no senior official in this department is satisfied with the present state of affairs as far as scientific policy generally is concerned in the Canadian government or the definition of its objectives, and that some other ways or means of co-ordinating goals—defining goals—should be sought.

The possibilities of a Ministry of Science, of course, are being considered by others and an attempt to place an emphasis on this area of activity and to act as a co-ordinator and a definer of goals. The opposition expressed in this brief to this concept is lucid and on page 12 an alternate suggestion is made in a case for an office of scientific affairs.

My first question is accordingly a request for amplification of this concept from the departmental officials and, particularly, a differentiation of the function of such an office of scientific affairs, a differentiation of its functions from those as presently carried out by, say, the Scientific Council and its ancillary operations?

Dr. Isbister: Yes, senator: I sense from your question that perhaps there is not much disagreement between what you are reaching for and what I was in my comments.

I did suggest in my comments opposition to a department of science defined in a particular way and that is a department that would include the scientific operations, activities, and research of the government. I think perhaps some years ago when the National Research Council was set up there may have been the idea then that not all, but quite a lot of the pure science of the government might be put there. I realize that this was not really involved even then, but it may have been in people's minds.

We are simply saying that we see no advantage for the government in putting, say, food research—that kind of thing—from the Department of Agriculture together in the same department with the National Research Council and with the pure research that is in our Mines Branch and in the Geological Survey Branch.

To the extent that we are increasingly able to develop criteria, benefit-cost analyses, and this kind of thing, to appraise priorities for research and development work at the applied end, these criteria relate, to our minds, not so much scientific fields to each other as scientific research and development to the industries and applications to which they are to be put.

In other words, I think one ultimately judges the worth, if you wil, of the Geological Survey by looking at the Canadian mining industry; this is not the only way, but it is a useful way. But whether one learns anything really in the way of priorities by relating research in the Geological Survey to fats and oils research in the Department of Agriculture, I am personally doubtful.

So I have in this argued against putting all the science in one departmental bundle. I have, however, associated myself—and I think the senior officers of the department—with the idea of a ministry that would do far more than has been done in the past to look at government support of science in a co-ordinated, integral fashion. Government must decide today what fields to select to back and what are the relatively less important fields. Scientific research today must be played with big chips and Canada, as a medium-sized country, has to choose the chips it is going to play with considerable knowledge and skill.

We have expressed our support for a ministry organized on this concept. We believe...

The Chairman: It is not in the brief.

Dr. Isbister: No, but in my comments, Senator, in the final paragraph. We also believe that the development of the ability to advise government in this sense is probably the main rationale for the Science Council—again not the only one, but we expect that with each passing year the Science Council will develop more and more ability to advise in this sense of co-ordination of priority, of general allocation of resources, of finance to particular fields.

Again to repeat, we are suggesting that these fields need not and should not be in that central ministry.

Senator Lang: Would you anticipate, Dr. Isbister, that the practical results of such a combination would leave little unchanged inasmuch as the balance or the weight of decision is going to still remain in a departmental area and that the advisory nature of the ministry or council is going to be sufficiently academic, let us say, or sufficiently unfamiliar with the specifics of the department's activity that it tends to lose its pre-eminence?

Dr. Isbister: In my view, Mr. Senator, the recommendations we are making would result in radical changes in modes of thinking and operation in the government.

In our experience people connected with the definition, the designing, the financing of scientific programs, are reaching for more rational, better advised ways of making the major decisions. We believe this would be welcomed in general; it would certainly be welcomed to us, and it is something we have lacked.

Senator Lang: I should mention, Mr. Chairman, that I appreciate the care that the department and its officials have taken in attempting to follow the guidelines suggested by our Committee and I realize the difficulty in compartmentalizing the information.

In that regard under major problems in the performance of departmental functions I think we see a fairly strong statement affecting the ability of the department to recruit into its ranks in a sufficiently flexible manner and the way that this is affected by the job

classification procedures imposed on them as a department and not an "exempt agency", I think is the word.

I assume, Dr. Isbister, that this job classification procedure technique is one that is inherent in a civil service system such as ours and is not one that we could dispense with very lightly in a general way. If a department such as Energy Mines and Resources was to be excluded from this procedure, I think possibly the utility of having such a procedure at all in any department could be very well argued.

Is it a practical suggestion that this E M and R should be removed from this structure? Could it be removed without affecting the whole of the civil service and all other departments of government? How could we differentiate the different departments?

Dr. Isbister: I have two brief comments on this, senator: one, I think we have drawn attention in our large brief to certain procedures which seem to us to be unnecessarily time consuming, and where one finds this in big organizations today in our experience it is always worthwhile giving a little thought to seeing whether they cannot be made to go in some different way with a smaller expenditure of resources on them.

In other words, where there are organizational problems, why not give a little bit of thought to overcoming them. That is one line of our thinking.

The other thought: you ask whether it is possible to exempt the department; I forget the exact language in the large brief at this moment. We can find it, but what is in my mind is not the exemption of the entire department, but I do have in mind that as far as the employment of scientists is concerned, scientists are a terribly important but not very large fraction of the employees of our department, that we should really have the same freedom to employ and administer these people as exempt agencies do and we are here raising the question of discrimination between federal government employers.

Senator Lang: I presume this would apply equally to any department so far as its scientific personnel is concerned?

Dr. Isbister: And I would so apply it, sir. We simply fail to understand the rationale or whether there can be a rationale for this discrimination which exists among the different important agencies of government that are in the scientific research business.

Senator Lang: To come down to a few relatively specific matters...

The Chairman: Senator, could you for the time being ask a final question, then we would come back?

Senator Lang: To specifics; I will break now then, Mr. Chairman.

The Chairman: Senator Grosart.

Senator Grosart: Thank you, Mr. Chairman. I would like to associate myself with what Senator Lang has said about your brief.

A newspaper science writer called me during the weekend with some general review of the science policy question. He called me from Ottawa and I said if you can get hold of the first few pages of this brief you will have about as good a run-over it as you will find anywhere.

I had intended to ask the specific question that Senator Lang asked about your observation about a science policy ministry; I think if I understood you correctly, Dr. Isbister, you have satisfied me now that you are not really against it, but you would like to raise a few warning signals?

Dr. Isbister: About what it does.

Senator Grosart: About what it does?

Dr. Isbister: Yes.

Senator Grosart: Yes, I would agree fully in that. I think my impression of the witnesses we have heard so far is that there is a trend towards acceptance of the idea of the science policy ministry. Dr. Solandt even seemed to come around to agree with that.

One wonders about the alternative, and in reading your brief it is obvious that you are concerned with this, because you are concerned with the high degree of subjectivity in your own decisions. You refer to this over and over again; you say you are searching for objective standards; you mention, for example, the national advisory commissions in several places and detail their work.

What do these national advisory commissions do for you?

Dr. Isbister: We have enumerated these National Advisory Committees in our brief;

there are several of them. I will try to give a general answer, although they are not completely uniform.

In brief, we request these committees to criticize our departmental programs and the results of them, and we do not ask them to administer the department for us. We take responsibility for the designing of programs for everything that is normally regarded as administration and we try to get on to these committees the best brains available outside the department in the country to look at what we are doing, what we have done, and to tell us as frankly as possible where we are going wrong, where we could have done better.

These committees are very frank in my experience and we get very good mileage out of them.

Senator Grosart: How often do they meet?

Dr. Isbister: This varies from one to the other, sir. I, myself, am acting as chairman of a new such committee in the field of metallurgy, advisory to work of the Mines Branch. At our first meeting we decided that we would not make decisions about how often to meet for some time, but after a few years we might fall into a routine. But that in the meantime we would meet as often as seemed necessary to get off to a good start. We prepared an agenda of work for a number of people on the committee; we expect the members to take responsibility as well as departmental people and we are meeting the second time in a little less than three months.

In general these committees meet at least once a year and quite frequently oftener but I do not think there is any set rule. Once a year is enough at a big meeting to look at the relevant programs and criticize them sometimes, and sometimes you need more.

Senator Grosart: You frighten me a little when you say the department prepares the agenda, because I was going to ask you do they do any examination of your programs on their own initiative, or do they themselves initiate examination, or monitoring, or anything in the nature of a technical audit?

Dr. Isbister: The answer to that is certainly affirmative; the agenda in these committees is in general responsive to the interests of the members. These are national committees—people with reputations, accomplishments in the relevant fields—and they are not in general the kind of people who would waste their time on any other program than the kind you have suggested. They take all sorts of initiatives.

Senator Grosart: What kind of initiative would they take in respect to any program in your department?

Dr. Isbister: In general they will suggest areas of discussion that they want opened up, and as they do they have access to people, papers, laboratories, really whatever is appropriate to satisfy their interests.

Senator Grosart: Do they have a secretariat?

Dr. Isbister: This varies, sir. We provide what I would call rather minimal secretarial functions; we do not staff these, we are not able to staff these advisory committees in any very ambitious way. Sometimes these committees are able to propose, for example, certain publications—that kind of thing—but the secretarial assistance provided by the department is what I would call efficient but minimal.

Senator Grosart: Would you say that the occasions are reasonably frequent when one of these committees might say, "It is not on the agenda but we think perhaps you have a program that you should be terminating"? Does this kind of thing happen?

Dr. Isbister: This particular one, not in my experience. This is a specific question and I am going to ask Dr. Harrison to respond to it, if he will.

Dr. J. M. Harrison, Assistant Deputy Minister (Mines and Geosciences), Department of Energy, Mines and Resources: In my experience no, this has not happened, and I would rather suspect, sir, that it is not likely to happen in this sense.

I might emphasize one other aspect of these national advisory committees: they do not, and are not asked to, limit themselves to the work of our department; they are basically national committees providing general comments and advice on the trends of research in the national interest.

For example, in water research, about which other members could speak more knowledgeably than I, there are representatives from industry, from universities, from

government departments and the exempt agencies, all of whom discuss the whole problem of water resources research. In this framework then the department can fit its own program, and, as well as having its own program reported to the committee and receiving criticism on it, it has a national implication as well as to where the soft spots are, where it might be developed, and various recommendations of this kind.

The Chairman: Do they have anything to do with programs and projects before they are initated?

On page 7, for instance, referring to the responsibilities of these committees, you say in paragraph 22:

> It is important to notice that this system works on the principle that it is the products of the department's activities that are subjected to review.

That means that they come at the end, when your research programs or projects have been terminated, then they analyse the products of those programs, or the results of those programs.

Dr. Harrison: This is true, sir.

The Chairman: So they have nothing to do with reviewing the programs or projects before they are initiated?

Dr. Harrison: Rarely, for the reason that Dr. Isbister mentioned a short moment ago, that they do not attempt to impose on the department their ideas of how research should be undertaken or administered, but they provide the framework in which the department can develop a program in relationship to other agencies.

The Chairman: But in their criticisms when they are dealing only with products or results, do they not come too late?

Dr. Isbister: Most of our programs are continuing programs.

The Chairman: So that in this respect in so far as continuing programs are concerned, they would not be exclusively examining results or products, but they would also review programs?

Dr. Harrison: Yes.

The Chairman: Which have already been initiated?

Dr. Harrison: Yes, and of which we can see certain results already.

Senator Grosart: I am following your line of questioning, Mr. Chairman: perhaps for the record I should indicate the names of these committees, to indicate the importance.

The Chairman: By the way, Senator, just to supplement this, I do not know if the members of the committee are aware of this, but we have also been supplied this afternoon with a list of the names of all the members of these committees.

Senator Grosart: Yes, I just wanted to put the names on the record; they are all prefaced by the National Advisory Committee on...First is Research in the Geological Sciences; there is the Committee on Geographical Research; the Committee on Astronomy; the Committee on Control Surveys and Mapping; the Committee on Water Resources Research; and the Committee on Mining and Metallurgical Research.

Now, I understand these committees may have a fairly specific function in respect to grants-in-aid for research. At what point in the decision to make a grant-in-aid are these committees consulted?

I am referring now to page 39, where I read the statement:

> They also review applications for grants-in-aid of research and recommend the disbursement of funds for this purpose.

Dr. Harrison: I think that practically any one of the National Advisory Committees, having discussed in general session the aims and objects and needs for research in a specified field, then appoints a sub-committee which can examine the requests from universities for grants-in-aid in support of research in that general field.

Having discussed in advance in plenary session the direction that they feel research ought to be directed, they are then in a much better position to be able to select those projects that will help to achieve the aims and objectives of the advice already made by the National Advisory Committees.

Senator Grosart: Would this subcommittee then examine applications for grants-in-aid from different departments?

Dr. Harrison: From different departments of universities; not from different departments of the government. This is only for universities, sir.

Senator Grosart: Yes, but these committees are ranging over an area that goes beyond your department, as you said.

Dr. Harrison: Yes.

Senator Grosart: What I am asking is when they review these applications do they review applications for all grants-in-aid of public money?

Dr. Harrison: No, only those in the general field in which this specific committee was established.

Senator Grosart: Yes, but do they from all sources? We are in water resources research, for example. There is more than one department concerned in that area.

Dr. Harrison: Do you mean, for example, political science or resource management departments?

Senator Grosart: No, I am saying if department A, B, C or D has applications or makes grants in let us say the water resources research area, does this committee look at them all?

Dr. Harrison: No, sir.

The Chairman: Only so far as you are involved though.

Dr. Harrison: Only so far as we are involved, but we do have overlapping joint membership with many other granting committees, so there is knowledge between all of them on what is going on in any other granting agency.

Senator Grosart: It might be a general knowledge, but what I am really getting at, Mr. Chairman, and I will finish very quickly, is what appears to be in this area and in many other areas a lack of control. Your own brief speaks of the Burlington problem, eight universities.

Who is responsible for this unwise disbursement of these funds among these universities? Where is the co-ordination, the common front to prevent this thing from happening?

We have scores of cases and if I may just point it up with one quotation; I read it to point up my own concern about the necessity for control in R and D expenditures.

This is from this morning's *Globe and Mail;* it refers to the report on the Dunnville problem. The *Globe and Mail* in an editorial summarizes the report; I presume it is a reasonably correct summary. It has this to say:

If the companies dealt poorly—

This is referring to the companies which were alleged to have caused the contamination in the area,

> If the companies dealt poorly with the problem, the Government was no better. A confusing total of five Government departments—Mines,—

I admit these are not federal departments at the moment:

> ...Mines, Labour, Lands and Forests, Agriculture and Food, Health—and several of their creatures, not to mention the Ontario Water Resources Commission, had all been unco-ordinately involved in assessing the difficulties. They had assessed them so differently that comparison between their assessments was impossible. Everybody was responsible and therefore nobody. Breakkdown of communications between the various departments was just about complete.

It was a regular Keystone Cops production.

What do these National Advisory Committees, or is there any other mechanism in your department to prevent this kind of thing happening? Co-ordination is obviously not the answer; what kind of control can we get in your department, or in other departments, of the expenditure of the public money on R and D so that we will know that there is a science policy in respect to the expenditure, an over-all science policy?

Dr. Isbister: I wonder if Mr. MacNeill could pick this up? Mr. MacNeill is the Assistant Deputy Minister in the water sector.

Mr. J. MacNeill, Acting Assistant Deputy Minister (Water), Department of Energy, Mines and Resources: Mr. Chairman, with regard to the National Advisory Committee on Water Resources Research, which is one of the newest, if not the newest National Advisory Committee in the department, if I could go back one step and mention that it has three

functions, as stated in the order in council; one of these is to advise the Minister on needs and priorities for research in the water resources field; the second is to facilitate the co-ordination of this research; the third is to advise on applications for grants-in-aid.

With regard to the first, advice on needs and priorities, this is something that is very dynamic, continually changing, but we have a good basis upon which to start the committee in the recent study by the Science Secretariat of Needs and Priorities in the water resources field. This is the study here on water resources research in Canada; they made a very comprehensive inventory of existing research. They had a number of studies commissioned to identify needs and problems in the water field. They related this to research requirements, and they came up with recommendations on needs and priorities for water resources research under some eight categories. This will provide the committee with a good start, and the committee expects in future years to continually review and update their evaluation and so advise the Minister with regard to co-ordination of water resources research in Canada. This is the point that you are talking about.

Senator Grosart: Excuse me; we were told in this committee that there were 228 entities claiming authority in the water resources field.

Mr. MacNeill: Is that all? With regard to co-ordination, we attempt to achieve this in part through the structure of the committee, through the composition of the committe. The committee is made up of senior representatives from, I believe, ten other federal agencies that have a concern in the water field or have concerns that are related to the water field. It is made up of another ten representatives from universities and provincial agencies. I believe that four or five provinces are represented on the committee by their senior water official, and there are industrial representatives on the committee, or subcommittees.

Through the composition of the committee, then, we have a means through which to effect some co-ordination of research as between, first of all within the federal government all of the agencis concerned, and as between the federal government and the university community and these provincial agencies.

How successful this will be remains to be seen.

Senator Grosart: Excuse me; do they meet once a year?

Mr. MacNeill: No; the committee has met twice in the last six months we will be meeting—this will depend on the committee—at least twice a year. The subcommittees will be meeting more frequently than that.

The other means through which we can exercise co-ordination and a degree of control is through funding. This report tells us that the bulk of funding for water resources research in Canada comes from the federal purse and in the future wil lhave to come from the federal purse. This report recommends that that funding be disbursed through the National Advisory Committee on Water Resources Research.

So that by control of the funding of the bulk of water resources research this committee will be able to exercise a greater degree of co-ordination.

The Chairman: At the federal level.

Mr. MacNeill: At the federal level, but keep in mind that the committee is not just federal; it is university, and provincial agencies are on it too.

Senator Grosart: Is the funding your only mechanism of control?

Mr. MacNeill: I would say that it is the significant mechanism; the composition of the committee is one and funding is the other.

The Chairman: In respect of international waters and rivers where there is a federal responsibility for control?

Mr. MacNeill: Yes, for control; I am sorry, we are talking about two different things.

Senator Grosart: We are talking about R and D.

Mr. MacNeill: I am talking of funding through the committee; the planning and control of international waters is a different thing.

Senator Grosart: So what we are back to is that the science policy ministry of the federal government is the Treasury Board.

I am glad to see you nod your head; I just wanted to put that on the record.

Senator Kinnear: Mr. Chairman and Honourable Senators: Senator Grosart has covered a great deal of the area I wanted to talk about and I wonder if I could talk about pollution and particularly in the Burlington area, where you have a 50-mile area with eight universities and a great many polluted lakes and rivers.

I enjoyed the brief very much and was so delighted to hear Dr. Isbister say on page 8 that:

> We have attempted to respond to the guideline as applied to research in the natural sciences. However, scientific research is not, and should not, be limited to the natural sciences, and the scientific work of our Department includes many socio-economic studies—the effects of water diversions on the life of communities; development of mineral resources and effects on the economy, the cost of pollution abatement as it will affect communities, and so on.

Then on page 12 he ruined my high hopes when he said:

> In my view our efforts are at too low a level by every relevant criterion. At present, our Department is indefinitely postponing what appear to us to be important programs pertaining to resource development, water management and pollution.

To me it is like going to take a music lesson from a very highly qualified master and you cannot get into the music room for the clutter. Today pollution is on everybody's mind, air, water and soil, but we will stay specifically with water. I would like to read from the New York Times of Wednesday, December 4th, about this 72nd World Parley on pollution:

> The date is set; the United Nations seeks to help protect the human environment.
>
> The General Assembly moved today to organize a world-wide defence against pollution. A resolution sponsored by 54 members of the 126-nation body calls for an international conference in 1972 to explore the possibilities of co-operation to eliminate the impairment of human environment.
>
> The resolution was presented to the Assembly by Sweden, the original sponsor. Swerdka P. Astrom, the Swedish representative, made the address. Speaking of the price of pollution of the seas, the atmosphere and the earth that results from man's technological advances and demands, Ambassador Astrom declared:
>
> Even if we avoid the risk of blowing up the planet, we may by changing its face unwittingly be parties to a process with the same fateful outcome.
>
> The resolution seeks to alert all nations to the need for understanding the relationships to his environment. It points out the dangers inherent in man's ability to change and shape his enviroment unless the pursuit of his goal is controlled.

All through your large brief you speak about pollution and I know that you have interrelated agencies by the score, but it seems to me we should now be coming down to the time when something could be done about pollution, particularly in the area to which I referred, where it is so heavily populated. I think we should be practical as well as scientific and probably get on with some of the practical aspects of our daily living.

The areas in the international waters of Lake Ontario, as I have said to so many of the agencies which have come before us, the Niagara River and Lake Erie, they are extremely badly polluted, and to hear it said you were going to delay this indefinitely is quite frightening to me because it is at the stage where something should be done, not at a much later date, but immediately.

I would like your comment on what you hope to achieve.

Dr. Isbister: The Burlington Institute, the Canada Centre of Inland Waters, has been started very recently and is at the beginning of what we hope will be a very useful contribution to the solution of the Great Lakes pollution. It is in a very interesting stage of development I might say. It has not yet its permanent buildings; it is carrying on in temporary trailer camps. We have taken delivery of one new ship. There is a vigorous, well trained core of young scientists, who are purposeful, well organized, their work related in meaningful ways to each other, and it is off to a start.

It is realistic to say that as far as the Great Lakes are concerned—I am not now speaking about every problem of pollution in the country—but so far as the Great Lakes are concerned it is realistic to say that the greatest contribution that can be made by the federal government or anyone at the moment is that of research.

Let me point this up just by saying concretely I am quite certain that if you gave unlimited money and resources to 12 different well qualified water scientists and told them to start spending it instantly to purify the Great Lakes you would have 12 quite different programs.

The fact is that knowledge has not yet reached the stage where we know enough to proceed to the desired ends, so that at this stage...

The Chairman: But yet Dr. Gray of Atomic Energy of Canada told us that pollution was not really a problem of research; it was a problem of control.

Senator Kinnear: That it could be done if we had sufficient money at any time.

Dr. Isbister: If you would like to pursue this in connection with the Great Lakes I would like to call on Dr. Prince to pick this up. Dr. Prince is here and is the scientist on whom our programs rely more than anyone else. Might I ask Dr. Prince to comment on this?

The Chairman: Yes please.

Dr. A. T. Prince (Director, Island Waters Branch, Department of Energy, Mines and Resources): Thank you, Mr. Chairman. This is a question with which we are faced from time to time, as to what the relative roles of research and abatement programs may be, and I think it is a good question.

I would say that if the present technologies and sufficient funding were made available immediately for the abatement of pollution that conditions would improve very substantially in the Great Lakes area, perhaps within the next five years or so, but one has to remember that pollution abatement based on present-day technologies is only a percentage removal of the pollutants. There is always the escape of 10 or 20 per cent of whatever is involved and it is the accumulation of these escaped amounts that is the serious thing, because it is cumulative. It is cumulative in the sense of growing industrial and population areas in the Great Lakes and other parts of the country, so that these residuals are accumulating and are putting a stress on the environment as time goes on.

Furthermore, there are many things in the nature of polluants that we do not understand yet in their effects on the environment, things from the industrial sector from present-day technologies, things that will be derived from the inventions of new processes and new products; these things are not well understood in the environment at all.

So that what we are endeavouring to do is to understand the environment, the lakes environment, which is a new one, and has not been studied in as great depth as perhaps rivers and some other mechanical water devices. We want to know how much the environment can stand, what materials, and particularly what materials which are deleterious, should be the ones on which most of our money and effort are spent, and this knowledge is not adequate at the present time.

When a statement is made that abatement could be effected by the use of large quantities of money at the present time I would say yes, this is true based on technologies that have developed without very much change in the last 50 years.

Senator MacKenzie: Could I ask just one question at this point?

The Chairman: A supplementary?

Senator MacKenzie: Have the Germans not in the Ruhr Basin done a pretty effective piece of work in the control of pollution?

Dr. Prince: Yes, I believe they have. I have not visited the Ruhr to examine it, but I have seen reports on it and I have spoken to people who have been there.

Senator MacKenzie: It is my understanding that their streams and dams and lakes and so on were reasonably pure and clean despite the amount of industry and population in that area.

Dr. Prince: Yes, Mr. Chairman, I think this is essentially true; they have a splendid abatement program for the Ruhr valley. One thing they do not seem to talk too much

about is the Emscher River, which is the next stream over, which is used as a sacrificial place for many of their wastes to go.

I might also say, Mr. Chairman, that the question of the sanitation and the abatement of pollution on rivers is a very much different problem from that in large lakes, because of the short residence time, the fact that the water remains in a river system for perhaps a few days, weeks or months, depending on the size of it, and it is very different from let us say the Great Lakes or other large bodies where there is an accumulation of these effects over many years and the effects of these accumulations are not worn off. What we are seeking to find out is the mechanics of diffusion, dissipation, removal and material balance, and so on, particularly in the Great Lakes.

I think I should mention too that Canada is a country of lakes, that our problem concerning control of pollution are somewhat different in Canada than anywhere else in the world. We have a much larger percentage of our surface covered by lakes, and while we have the large lakes in immediate areas of heavy population causing trouble at the present time, we must and I think are effectively developing competence to deal with Lake Winnipeg and Winnipegosis and Athabaska, and the lakes on up through the country, which will be the problems of the future.

The science in the technology of lakes management is in a very primitive state at the present time, so at the Canada Centre for Inland Waters at Burlington we are endeavouring to bring together very realistically scientists to grow up with this technology, to grow up with the science of lakes management.

I would not concur in the idea that the solution to the pollution problem on the long term basis could be solved simply by abatement measures as they now exist.

Senator Kinnear: But the Niagara River is in a dreadful condition with the drainage problem on the American side from the industries over there; it just carries all that emission from Buffalo straight down to Niagara Falls and into Lake Ontario.

Dr. Isbister: Could I please add, Mr. Chairman, a couple of generalizations?

The federal government has offered to support pilot projects in each of five major areas of the country designed to introduce new methods of water management control and purification or depollution, whichever you like. It was announced just a week or two ago that British Columbia is now in negotiation with the federal government with regard to the first of these; the sooner the others come along, the better.

What we are proposing here in brief is the application as soon as possible of known and available methods to deal with problem river basins on the most contemporary and effective possible way.

The other comment I would like to make is that when we make comments about delays our comments too are made out of impatience. I would like to say that our scientists in the water sciences and elsewhere in our department are people in a hurry; they are working in these fields because they are looking for results and never in my experience trying to hold back practical work so that they can find time for a little more research.

Senator Kinnear: The trouble is that five or ten years in this particular era is disastrous almost.

Dr. Isbister: I think this is a field, Senator, where we are all in a hurry.

Senator Grosart: Could I ask a supplementary question of Dr. Price: Taking the Great Lakes as a case history from which we can get the kind of information we are looking for, how many agencies in total are spending money on research on the Great Lakes pollution problem? How much are they spending; how long do they anticipate it will be before they will have achieved the competence to recommend an abatement program?

The Chairman: I am sure you will want to take notice of that one.

Dr. Prince: Yes please, Mr. Chairman.

The Chairman: If you can answer the first question, how many agencies are involved?

Senator Grosart: Just take a guess; I would like to know how many agencies are in this field. Is it a hundred, two hundred? How many people, roughly what is being spent, and how long is it going to be before they have this competence?

Dr. Prince: Mr. Chairman, I really cannot answer that question definitively; I presume, Mr. Senator, you are referring to both sides of the international boundary?

Senator Grosart: That is right, or I will take the Canadian side; anything that will give me some kind of a clue?

Dr. Prince: Looking at the Canadian side, the chief responsibility for abatement of pollution lies with the Ontario Water Resources Commission, and we are working with the Ontario Water Resources Commission as well as with the Department of National Health and Welfare with our own scientists and engineers at the present time in support of an International Joint Commission reference on pollution of Lake Erie and Lake Ontario and the upper reach of the St. Lawrence River.

This program is under way; all these agencies have been engaged in studies for the past three summers. They are writing up the report, which is expected to be available by mid-1969.

The Chairman: But do you mean that at the federal level there are only two agencies involved in this?

Dr. Prince: The Fisheries Research Board I believe I did not mention, but they are involved.

Senator Grosart: But the Ontario Waters Commission; I read eight or nine names in your own annual report of people who are dealing with this problem, and Energy, Mines and Resources.

Dr. Prince: I refer to Energy, Mines and Resources as one agency; there are several divisions and branches involved in this within our own organization.

Senator Grosart: Yes, they are entities, are they not?

Dr. Prince: Entities of that kind, yes.

Dr. Isbister: Or closely interrelated; these are not independent agencies.

Dr. Prince: No, that is correct; the total number, Mr. Senator, would be a pure guess on my part, but if I guessed including the municipalities and the industries and the states on the other side I would think perhaps 200 would be a fair estimate of the number of agencies involved, entities of one description or another.

Senator Grosart: I am not optimistic enough to believe that they can be co-ordinated without control.

The Chairman: Senator Cameron.

Senator Cameron: Mr. Chairman, I was very much interested in the frank expression of a point of view, which is held by others, by Dr. Isbister, as to the need for the department doing its own research.

I notice on page 5 of his summary something that raised a question in my mind. He said:

> Questions could be raised as to the advisability of carrying out such esoteric research in a government department—indeed the Chairman of the Science Council has specifically questioned this point before this Committee. My own feeling . . .

And this is the part I want to underline:

> My own feeling is that the matter of jurisdiction is not terribly important, so long as the funding is provided and other astronomers have access to the instruments.

You were speaking here, I take it, purely on the astronomy factor?

Dr. Isbister: Yes, indeed, sir. We are drawing attention to the fact that we and others have wondered whether such a pure field of research as astronomy belongs in our range of research, but traditionally it has, it has been accepted there, and I just wanted to make a comment on it in this presentation.

Senator Cameron: There is a consistency through your whole report that intrigues me a bit, and that was one of them. On page 6 there is a reference to:

> Moreover, under the sponsorship of the Associated Colleges and Universities of Canada, a working group has been established to help guide the policies of research at the Centre. Nevertheless, it seems to us to be unwise and even dangerous for eight universities in one small area to attempt to become specialists in research on water.

I think I would agree with that statement, but is this likely to happen? Can this kind of diffusion of research resources happen under a plan of this kind?

Dr. Isbister: Not with our support, sir; in the last sentence of that paragraph I said:

> The solution to this problem must be found by the universities themselves and we are confident they are in the process of doing this.

This is really a problem I believe for the province of Ontario and its universities. We can point to the problem but I do not believe that the federal government or our department can help much to find a solution; we believe that they will.

The Chairman: Or else.

Senator Cameron: Or else they will not get any money.

Dr. Isbister: I did not say that; I just said we believe that they will.

Senator Cameron: On page 8 you are referring to the Canada Centre for Inland Waters; you are one of the few people so far who have mentioned social scientists and the provision for them.

Now, is this the only area in which your department is concerned with social scientists, or is this the only institution?

Dr. Isbister: No, sir; it is a major area and water planning involves on the side of origin consideration of the people and the industries who are going to use it, what they need, how much they are going to need, where they need it, twenty years ahead.

We have similar programs in the fields of mining, minerals, and so forth. We try to look at what we have called the socio-economic aspects, and in this field as in others we are never satisfied with what we are doing; we are always planning on doing it better.

Senator Cameron: This is a relatively new institution. How many social scientists have you employed now and what kind of establishment are you thinking of, or is this not a fair question at this time?

Dr. Isbister: I would have to take notice on the matter of number, how many in the entire department.

I can tell you that this is a field that we have been short in, under budgetary pressures, and the expansion of these particular areas has been held back in the interests of even more urgent areas during the current budgetary austerity.

Perhaps Mr. Drolet, who is in charge of one of the important areas in the field of mineral development would like to add to this; this is Mr. Jean-Paul Drolet.

Mr. J. P. Drolet, Assistant Deputy Minister (Mineral Development), Department of Energy, Mines and Resources: For instance, in the mineral development sector I do not have in this group somebody who is a specialist in social science, not as such, but much of our work in the field of mineral economics is related to problems that have social implications.

Let us take, for example, the coal problem in Cape Breton. There is almost a problem that was exclusively concerned with the unemployment of the people, as a social problem. Another area that I can point out in general is the area of these mining towns where gold mining is the main occupation of the people and due to the low price of gold and changing markets, et cetera, there it becomes a social problem.

In this light I can say that we are working in this field, so that the people are mineral economists. They are also geographers, et cetera, but no people, social scientists as such.

Senator Cameron: Following that up, you would include, I suppose, some responsibility for what happens in the flooding of an area like the Mica Creek dam in the building of the dams on the Columbia which resulted in the removal from their homes of large numbers of people. I also believe there is a great row now in New Brunswick on the same matter at the present time. This involves social and economic science as well.

Now, you say you have not a lot of people directly concerned with social science dealing with this.

Mr. Drolet: In the mineral development sector, but now you are talking about the water sector?

Dr. Isbister: Yes, I think this should come back to Mr. MacNeill.

Mr. MacNeill: Perhaps Senator, I could comment on that: In recent years we have become, we, the water resources community in Canada, federal, provincial and university, have become more and more conscious of the fact that water resources planning has to be

approached on an inter-disciplinary basis. That is, the technical problems are only one of the sets of problems that have to be considered, the location of dams and other structures.

We also have to consider the effect of water development on communities, on the economy of the region, on fish and wildlife, on recreation. Many of these structures do involve serious dislocation, not only to humans but also to wildlife, and these dislocations and disbenefits have to be taken into account.

This is one of the reasons why we are endeavouring to increase the social science capability in our planning organization. It is also one of the reasons why we have offered the provinces a pilot study in five major regions, to give us an opportunity and to give the provinces an opportunity to test the application of these techniques in a planning exercise.

The Chairman: But when you make these manpower studies and when you try to deal with problems at the regional level, do you conduct your research in close co-operation with the Department of Immigration and Manpower, because they are doing this too?

Mr. MacNeill: I think perhaps we are again talking about two different areas, Senator. I am talking about the possible effects of the construction of a major dam or a major reservoir on an existing community or on existing fish and wildlife resources.

The Chairman: Let us take the Cape Breton case, because I am sure that the Department of Immigration and Manpower conducts all kinds of surveys of manpower problems which are developing.

Dr. Isbister: Perhaps I could pick this up, Mr. Chairman, because I was involved in some depth in the studies and advising the government with regard to the solution of the Cape Breton problem for some time.

In this case our department took the leadership in connection with background studies, but we worked closely, intimately with Manpower and other relevant government departments. We made shameless use of them, exploited them all as much as we could, and I believe it is true to say that we drew on all the resources that were available to do those studies.

There was no duplication, certainly.

The Chairman: But you were more or less assigned a specific role in this kind of over-all exercise?

Dr. Isbister: Yes, we were indeed.

Senator Cameron: The reason I ask this is because I want to get this aspect emphasized, because I think that it is going to be of increasing importance as time goes on.

To take another example in the same mining field, Belle Isle, off Newfoundland, there is a tremendous social and economic and manpower problem there.

Dr. Isbister: Yes.

Senator Cameron: Now, this leads me to the next one: I just made a note here on the bottom of page 8, "Is he not satisfied with the degree of co-operation between his scientists and the universities?"

There might be an implication, I may be reading more into it than you meant.

Dr. Isbister: Is this the summary?

Senator Cameron: The summary, yes.

Dr. Isbister: I am sorry, Senator; I am dissatisfied about so much that I cannot recall this.

Senator Cameron:

> Field projects in the earth sciences under the sponsorship of the Department have been accepted by some universities for about 50 years, but laboratory studies have been slower in gaining acceptance. We realize that universities must monitor the research but our engineers and scientists have world wide reputations in their specialties and would be pleased to assist in developing graduate research programs.

Perhaps I am reading more into this than I should, but I take an implication that maybe there is room for more co-operation between the universities than is presently going on.

Senator MacKenzie: But is this not a typical situation, Senator Cameron, in respect to universities?

Senator Cameron: Very likely.

Dr. Harrison: The point here I think, sir, is that we have felt for a long time that the

laboratories that are available in departments such as ours would be ideal locations for students to carry out graduate research projects, the results of which could be used to obtain graduate degrees from the universities, but this is pretty rare thing that happens. We have had some encouraging trends from the Bedford Institute of Oceanography at Dartmouth, Nova Scotia. We have also had some encouraging trends from some of the other areas in the department, but it seems to us that the universities who have in Canada for many years accepted the supervision, if you like, of some of our scientists on field theses, still will not accept the supervision of our people on laboratory theses.

It seems to me that this is a great waste and that more advantageous use could be made of this by universities.

Senator Cameron: This is the kind of thing I want to get at.

Dr. Prince: May I comment on this? In connection with the Canada Centre at Burlington, Mr. Senator, we approached the university community about the possibility of putting in a separate institute on that site for university use, and this was considered favourably in the first instance. But with further consideration the university community dcided they did not want a separate establishment on the site and requested that we provide accommodation for them within the various discipline areas in the main institute, and suggested that they would be quite agreeable to some of our staff after they were fully qualified becoming honorary professors and directing the studies of students in-house.

Based on this requirement we are at present in the last stages of planning for some 61 university personnel on the Burlington site to be drawn not only from the eight universities that were mentioned, but available for country-wide occupation by whoever is interested in the type of things we are going to be doing there.

So it is interesting in this connection that the universities had requested an integrated approach with the establishment of the institute.

Senator Cameron: This principle has worked very well in the plant pathology area where federal scientists are, as you said, honorary professors in many of the Western University faculties. It has worked very well.

I would like to tie this in now: There is a lot of unrest among social scientists today in universities. Are you getting any requests, or are you employing any university social scientists, say in the summer season, on some of the social science problems in your area?

What I am thinking of is here we have faculties of social science and I have been told that they are not dealing with practical problems; they are often in the stratosphere, and let us get them down to earth.

This may be overstating the situation, but it would seem you have some very practical problems here where you could put some of these people to work.

The Chairman: I suppose they do not want to come any more; they have received grants from the Canada Council.

Mr. MacNeill: Could I respond to that within the context of the water resources field, Mr. Chairman?

I mentioned earlier the National Advisory Committee on Water Resources Research; we have brought the university community, including the social science people, into this area through membership of the National Advisory Committee.

We have also established a special subcommittee on social science research in water resources. This social science subcommittee consists of about 15 people, of whom 10 are social scientists from university faculties from all across Canada, so we are involving them in that way.

We are also involving them through now making available grants-in-aid of university-sponsored research on the social science aspects of water resources research. This is mission-oriented research.

Senator Cameron: Would it be possible at some time, I am not asking for it now, to get a statement of the people in the social science field who may be working in the water resources branch, in the mining branch, and the others?

Mr. MacNeill: Working in them as employees?

Senator Cameron: As employees, or with assistance on special grants.

Senator Robichaud: Mr. Chairman, most of the questions I had in mind have been asked and answered as they had to do with water resources and pollution.

In the matter of pollution there is a specific question which I would like to ask: When there are so many agencies involved there is bound to be a conflict of jurisdiction, whether at federal, provincial or municipal level. Now, my question would be are there any acts or legislation or regulations within the Department of Energy, Mines and Resources by which the department can take action to force industries, municipalities or others concerned to implement measures which have the result to abate the pollution situation?

In other words, has the Department any authority to act? Now, they have authority to study, to make certain research, but can they take action in a certain condition or situation where pollution does exist?

Dr. Isbister: Our department has no direct administrative authority. In rather general terms I suppose the most powerful instruments that the federal government finds at hand are the Fisheries and Navigation Acts. Our department has been given by the federal government general responsibility for co-ordination of the work of federal departments that are in fields of water management, water pollution. This is a very effective function; it is developing increasingly and I am happy to see from one six months period to the next the improved results of this, but this is a concept of co-ordination without authority, this is a co-ordination function.

Most of the direct regulatory authority in connection with water pollution in the country is in fact in provincial hands. I have mentioned important ones that are in federal hands.

Senator MacKenzie: Mr. Chairman, like Senator Robichaud most of the questions that have been put are the ones that I would have put and they have been answered, but there are one or two points.

I happened to find a very attractive pamphlet on my desk at noon today having to do with the use of the water resources in British Columbia. It was brought out under one of your agencies and in it it was stated that about two-thirds of the stream flow was not presently available for practical use because the stream flow had occurred on the short Pacific slopes of the mountain region.

Now, water is a tremendously valuable asset if it can be used and I would hope that some day the people of British Columbia and of Canada might find an economic use for this additional stream, perhaps by exporting it and selling it.

After all, the Scotch are exporting water from the Highlands to make whiskey in New York, so we could export some to California for this and other purposes. As you will gather, I come from British Columbia at times.

The Chairman: When you see fit.

Senator MacKenzie: And I am tempted, of course, to tell Dr. Harrison what he already knows, that there are some members of the universities and communities there interested in astronomy that are not particularly happy at the present time. I will not say any more about that; he knows all about it.

I am not yet prepared to agree with the conclusion of my colleague, Senator Grosart, that the general trend of opinion of those who have come before us has indicated a desire for a Ministry of Science.

Senator Grosart: Science policy.

Senator MacKenzie: I am not yet prepared to accept that as either their desire or the best answer. We have spent a deal of time on a matter of major interest and that is water pollution and water uses. Somewhere I read recently that the motor car was in the process of becoming more lethal than the atomic bomb was ever likely to become and might so change the nature of our environment that it would not be habitable for man nor beast.

Now, this grows out of urbanization, or at least in part. This, like water and pollution, is one of the major concerns of our contemporary society and I was wondering whether your department, Dr. Isbister, is involved in this and working at it, or whether it is outside your field of interest?

Dr. Isbister: We would like to be even more involved than we are, Senator; our Mines Branch is doing some very constructive, useful, and interesting work in connection with air pollution, fuels research and the control of damaging elements in smoke.

If you would like to visit our laboratories one day you would see some very advanced work being done by some very well qualified people and work that has found very practical applications in different ways in the country.

Senator MacKenzie: Do you get effective co-operation here, or is there the same dispersion of effort that Senator Grosart suggested there is in respect of pollution and water?

Dr. Isbister: As far as the federal government is concerned, the government is addressing itself now to the problem of what it should be doing about atmospheric pollution and there is not the same degree of co-ordination of atmospheric pollution programs in the federal government as has been given to our department in the field of water pollution.

Senator MacKenzie: You realize only too well that pollution is only one of the problems of urbanization.

Dr. Isbister: Oh, yes.

Senator MacKenzie: There is the whole question of transport, communications, practically everything in the area of human living.

Dr. Isbister: We are increasingly concerned, sir, about the pressing nature of the pollution of the environment, air, earth and water. These are important, pressing problems which, as you say, are growing with urbanization and goodness knows, urbanization is growing.

Senator MacKenzie: This I hope is something somebody is doing something about.

The Chairman: In Table 22 you mention that your total expenditures at present for 1968-69 are about $110 million, and that the share of your scientific activities, including research and development, is about $83 million, which makes a proportion of about 70 per cent as far as expenditures are concerned in your department.

Would you have a similar figure to indicate the share of your staff in the department which is dealing with your scientific activities as opposed to your other administrative responsibilities? I notice, for instance, that you have a number of programs that you are administering, like the payments under the Emergency Goldmining Assistance Act, and things like that, but I would presume that although you devote about $30 million to these programs, that the administration and the personnel involved in the administration of these programs is not very important as compared with your staff in the research activities.

Would you say that 90 per cent of your staff are directly or indirectly engaged in scientific activities?

Dr. Isbister: No, it would be a little less than that. I have a feeling that we have some figures here some place.

I think it would be best, Mr. Chairman, if it would be agreeable to you, if we could take this question as notice and send you a memorandum on this; I am sure we can get what you are asking for.

Dr. Harrison: There is a point that needs a little clarification, I think: by people directly concerned with research or scientific activities?

The Chairman: I mean scientific activities in general.

Dr. Isbister: Including surveys?

The Chairman: Yes.

Dr. Harrison: In this I presume, sir, you would have us include the ships' crews.

The Chairman: Yes, because they are indirectly concerned with it; they are some kind of supporting personnel.

Dr. Isbister: If you take such a broad point of view as that, then it would be a very high figure, but we could send you a more accurate figure after we give it a little thought.

Senator Cameron: Do you not think, Mr. Chairman, that that should be broken down between the science personnel and the supporting personnel?

The Chairman: We have a breakdown for those who are engaged in scientific activities and I presume that the figures we have here include these people engaged on ships, for instance if the ship is used exclusively for research, or mainly for research activities, so we will have here not only the scientific and professional personnel, but also the technical personnel, the administrative personnel, and even the casual workers, because although they are not directly doing any resarch they are part of a research team.

Dr. Isbister: Yes.

The Chairman: That is why I was more or less of the view that it might probably be higher than 90 per cent.

Dr. Harrison: It would, certainly.

Dr. Isbister: Yes, it certainly would be. It is a very substantial proportion.

The Chairman: On page 35, paragraph 84, you refer to the concept of an Earth Sciences Institute which would have been patterned along the lines of NRC and you say that some of your senior people in the department were in favour of such an arrangement.

Would you care to elaborate a little bit on the pros and cons of this kind of organization as opposed to the one you have now?

Dr. Isbister: We have attempted in fact to do this in the biref.

The Chairman: It is not very long.

Dr. Isbister: No. The major consideration I think in our minds was the mission orientation of the department in the water field. We are trying to do a job and we are trying to create an organizational framework in which the scientists and everyone else will be contributing to national purposes.

Our feeling was that by taking the scientific complement out of the department, out of the water sector, and putting it off in a separate scientific institution would not be nearly as relevant to achieving results.

In other words, our decision was based mainly on a mission orientation of the department.

The Chairman: But we have mission oriented Crown corporations at present. Let us take Atomic Energy of Canada; they are certainly mission oriented and they seem to be pretty satisfied with their present status and you seem to feel that being constituted as a department means a lot of constraints and limitations, especially in your relations with the Public Service Commission, because I would presume that if you had chosen this other formula and had asked for a special institute along the lines of NRC that then you would have been an exempted institution.

Dr. Isbister: I agree that the Crown agency form is extremely useful in certain circumstances and I have myself on occasion advised the government over a period of years in favour of setting up some of them that have been set up.

You mentioned Atomic Energy of Canada Limited; this is a most successful, efficient body that has scientific research and a good deal of other things as well.

It is set up in a field that could be designed and separated from the day-to-day concerns of government and met that kind of criterion that must be met by a Crown company or agency.

The Chairman: Take, for instance, the Defence Research Board?

Dr. Isbister: Oh, of course, but the field of water policy is so intimately connected with political decision making on a day-to-day basis, and in general the field of energy policy in which we have co-ordinating responsibilities. The time may arrive when it will be possible and expedient to hive off some part, or even the total of some of these activities into Crown companies or agencies.

When it becomes possible, I think in general the view of bureaucrats like myself is that this is a very good idea. It simplifies the job of a minister and a department to take out a major block of work and put it into a separate organization, where this can be done.

But these major fields for which we have responsibility for co-ordination and particularly water and energy are fields which, in my judgment, it would really be too difficult to try to move from government departments at present.

The Chairman: Take the Fisheries Research Board, for instance; they have a kind of independence of their own and yet apparently, although they have not come before us yet, still they are very immediately related to the department.

Dr. Isbister: I agree that the Fisheris Research Board is an extremely important body and one with which we co-operate and one on which we rely in many senses, but the implications of its research are by no means as broad nor have as many political implications or involve as many ultimately political decisions as, say, the water field in general.

I would simply rest my judgment on that difference.

The Chairman: There are so few political decisions apparently that we can take in this whole field of energy and mines at the federal level that perhaps there are less policy decisions to be taken there than within the Department of Fisheries, where there is a definite constitutional responsibility.

Dr. Isbister: In the field of water I might just say that there is hardly a week goes by without some sort of summit meeting, conference, agreement federal-provincial in the water field and as long as the field in general is in this state I would see small hope of putting it off into a relatively quiet Crown agency.

It must remain directly in contact with the minister and ministers and the structure of government departments while this kind of thing remains true.

Senator Lang: On page 69 Dr. Isbister mentioned the functions of the Energy Development Sector and its co-operation with the National Energy Board, etc.

Is your department equipped to make an independent assessment of AECL as to the use of a Candu reactor or a breeder reactor, or where our nuclear programme should be heading?

Dr. Isbister: Our answer to that, sir, is simply no.

Let me say briefly that we are not equipped or intended as I understand it to second guess AECL with regard to the substance of its own programme; we are certainly not equipped to do it.

Senator Lang: On page 95 there is a mention of qualified people who have left the department. I am just trying to get some response with regard to the personnel problem and how serious that may be and as to what underlying causes or factors there may be.

It seems that the total number lost with higher qualifications has been increasing in latter years and it is mentioned on the next page that conditions of employment outside government are at least as attractive to professional employees as those within government. Salary does not seem to be a major consideration.

Can you amplify that at all, doctor?

Dr. Isbister: I will try, Senator; I'm not very happy myself with the clarity of this page and a half; I tried to make it as clear as I could.

When you are talking about the best scientists you can never buy them for an extra $2,000; that is not what they work for. You can only buy them for $20 million; in other words, the best scientists are looking to be in a place that can offer them the best facilities.

Senator Lang: And the greatest challenge, I presume.

Dr. Isbister: And the greatest challenge. This is typical of the most active and productive scientists during their best years.

We seem to deny here that people have left us because of salaries; I think this is a very difficult matter of judgment. I am quite certain that many of our earth scientists in the last couple of years have received and accepted better offers from universities than we could make to them. The conditions of employment in universities have become quite attractive and if you think of the whole bundle of salaries and working conditions I am quite sure that we have been losing out a little bit in competition, but we are not mentioning this as a major problem and I am not mentioning this as a major problem.

Now, I do not think it is major, but in the market for scientists we are losing a little rather than gaining a little; this is my judgment at the moment.

Senator Lang: I notice and it perhaps ties in with the tables on page 138, where it is showing the personnel in the department with doctorates, that in the first table, no. 14, on page 138, that those holding Canadian degrees amount to about 51% and on page 140 it amounts to about 39% or 40%, which would indicate a high degree of importation of talents from other countries.

Is this a supplement to the problem that you first mentioned?

Dr. Isbister: Perhaps it is, although not expressly in my mind. The fields of work in which we are very international; there is a flow of people in and out. There are parts of our programme where we are in a very leading position, not only in Canada, but in the world and in a position to attract people because of the very substance of the opportunities we are offering.

Senator Lang: Could you name those, doctor?

Dr. Isbister: When I have visited our oceanographic institute at Dartmouth, I have been very interested on each occasion I have been down there to find the odd ocean scientist from the United States who has just arrived. This is a place where oceanographers in other countries seek the opportunity to work because they have a good research station with good facilities and a good team of people organized in the right way, functioning in the right way.

Where we can do this we have no fear of a brain drain.

Senator Lang: Are there any other particular areas of excellence that you could mention? I feel often the test of the efficacy of a department such as yours is the excellence it achieves in certain specified areas and how widely that excellence is accepted abroad.

Dr. Isbister: Since I am not one of the scientists myself I can talk immodestly about the department as a whole: the earth scientists in our department I think have a name throughout the world quite literally. The best evidence of this is the people who have come to us for technical aid from underdeveloped countries and from other countries as well.

I spoke in my oral submission about the tradition of the Geological Survey of Canada, which is the very oldest of our geoscientific branches, but this is a very long and proud tradition, not only an old one. But on a contemporary basis, speak to people elsewhere in the world about what is the leading country in the world in the field of the geological survey and the answer is Canada.

We feel the same way about our Mines Branch, about what we are doing in the field of surveys and mapping and other areas of science in our department. There are none of them for which we would apologize. We are unhappy sometimes, and our scientists are sometimes unhappy about the sort of total level of support, but our research and our surveys are both efficient and at a good level of quality in my judgment.

Dr. Harrison is the leading scientist in our department, if not in Canada and perhaps he could amplify this. His judgment, incidentally, is better than mine.

Dr. Harrison: Thank you, sir.

The Chairman: He will be perhaps more humble, though.

Dr. Harrison: I think it is quite true, sir, that our departmental people are recognized as among the outstanding men in the world in their particular fields. We cannot cover all the fields with our sciences, for example, and I think we have been judicious in selecting those areas in which the department will emphasize. And as a result we have been able to attract good people and keep up good interest in the kind of work we do, even though it is directed generally speaking towards serving the end of government itself in the national interest.

I might also mention another point about the movement in and out of the government of highly trained people. Because our government service is highly qualified and it does have a broad range of activity, many people join the service in our department with the considered idea of staying for five, six or seven years and then going elsewhere as a fully trained and a better trained scientist than they could become elsewhere. We always have a certain turnover in all branches of this kind of individual and I think this is good; I think we will lose something if we ever lose that turnover.

The Chairman: And you want to have more?

Dr. Harrison: Yes; so that it is not necessarily always bad when people leave. What is bad is when there is a sudden surge of people; this indicates that there is some imbalance somewhere, or dissatisfaction.

Senator Grosart: I would like to return very briefly to the general question of programme selection and analysis. On page 17, for example, you gave us ten criteria; then again on page 22 you give us five criteria by which you judge the acceptance of the programme. Incidentally, there I must say I am quite surprised to see this statement that you rely so much on the principle of the judgment of peers, which has been adopted by the Public Service Commission as the means of judging scientific work.

I was not aware that that had been adopted by the Public Service Commission, but I am sure it has. It should be a caution there,

because this phrase, of course, comes from the prerogative of the peers in the United Kingdom in the House of Lords when charged with a crime to be judged only by their peers. It had to be rescinded, of course, because it was found that judgment of peers to peers was too kind to peers.

I was a little afraid that this might occur here, but you very interestingly on page 17 mention that the Hydrologic Sciences Division of the Inland Waters Branch has come up with twelve criteria of selection of programmes. Could we have those? I do not mean now, I do not think we have time now, but I wonder if we could have them?

Dr. Isbister: Indeed, sir, we can send you something on this.

I wonder if I could comment briefly, though, on your reference to page 22, the measurement of operational effectiveness: perhaps this page is not written with the clarity with which it should have been but in fact I think it is responsive to one of the questions put to us by this committee as to the department's operational effectiveness. I would not want to give the impression that in the department's administration in the choice of programmes and the administration of the department that we follow a sort of general process of consulting our peers to get advice on all these matters. Perhaps there is some misunderstanding in the way it is written.

We shall indeed send you some description of the twelve factors and the cost benefit ratio. I will take an interest in reading it myself before you get it.

Senator Grosart: Are you reasonably satisfied, Dr. Isbister, that the monitoring or the technical audit, internal process procedures, in the department are reasonably effective in assessing the on-going programmes in respect to cost benefits and the standards that you have mentioned? Just the mechanism?

Dr. Isbister: The literal answer to your question, sir, is no, but we are trying to make them so. These ideas are, relatively speaking, new in the department, and the senior officers of the department who are represented here with me today are a group of people who have been working very hard trying to introduce and make optimum use of some of these contemporary administration aids.

I might add that I personally have used some of these things and studied some of them and I do not think that any of them are calculating machines that can do your thinking for you; all of them are aids and we expect to make increasing use of them.

The Chairman: Machines have no opinion.

Senator Grosart: I think in another capacity you imposed some of these assessment mechanisms on hapless public servants?

Dr. Isbister: I did?

Senator Grosart: When you were with Treasury Board; I have heard it said.

Dr. Isbister: If so, I apologize, sir; I do not remember.

The Chairman: I am sorry, but it is six o'clock. I am sure the members of the committee will have a lot of questions to ask. Speaking for myself, certainly I will have other questions to ask. We will have to look at our schedule and perhaps communicate with you again, because I do not think we have done justice to all parts of your presentation. At a time of mutual convenience we will issue another invitation to you and see whether we can go on with this discussion.

Dr. Isbister: We shall be most happy to come at your convenience, Mr. Chairman.

The Chairman: At your convenience, too.

Dr. Isbister: If it is possible to give us any advance indications of the subjects you would like to cover, we can be more helpful in meeting your questions.

The Chairman: This is very difficult, because I find that the members of the committee are very difficult to control.

Dr. Isbister: I am not suggesting this, sir; we would be in any event pleased to come.

Senator Cameron: I will give you one you might think about which we have not touched on. It is a major topic that is coming up and it relates to the oceanography work: the United Nations is very much concerned about the harvest of the seas, and what we do with the off-shore; this is a very big area in itself. This is something that I would like something on before we finish up.

The Chairman: Well, thank you very much indeed for having been so patient.

The committee adjourned.

APPENDIX 14

BRIEF
TO THE
SENATE OF CANADA SPECIAL COMMITTEE
ON
SCIENCE POLICY

Submitted by

DEPARTMENT OF ENERGY, MINES AND RESOURCES

November 1968

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DEPARTMENT OF ENERGY MINES AND RESOURCES

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BRIEF TO THE SENATE OF CANADA SPECIAL
COMMITTEE ON SCIENCE POLICY

INTRODUCTION

1. Canada is a nation almost embarassingly rich in natural resources. But many other nations, also rich in resources, are much less affluent than Canada. It is evident that, to ensure prosperity, the existence of resources in the ground is not enough; the existence of a highly trained body of men and women capable of bringing these resources to light, and of utilizing them effectively, is essential. Indeed, scientists and technicians are more valuable to a nation than natural resources, as is shown by the example of nations whose lands are almost bare of natural wealth, but which have managed to build for themselves a prosperous life thanks to technical and scientific achievements.

2. It is true that technology, along with the results of research done elsewhere, may be imported. Foreign technology comes in with foreign capital, and at certain stages in a country's development may exert a very beneficial effect on the importing country. Such technology however is invariably tied to specific resources and special interests, and cannot be expected to be developed and applied with the long range interests of the host country in view.

3. On the other hand, the research and technology being developed and encouraged by the Department of Energy, Mines and Resources has as its objective the well-being of the country as a whole. It is indigenous, related to the particular conditions and requirements existing in Canada. While the Department encourages the utilization of relevant research and technology developed elsewhere, it recognizes the truth of the dictum of the painter Corot, who observed in another context that those who follow are always behind.

4. The principal function of the Department is to obtain and make available information about Canada as a country, about Canada as

an economic and sociological unit, and about the technologies needed to develop its non-biological resources, so that the initiative and capital of those engaged in utilizing and developing those resources can be employed in the interests of Canadians in the most effective way. While the Department is concerned with the whole of Canada, it takes a special interest in the North, in the oceans, and in underdeveloped areas generally, as particular areas where opportunities for activities beneficial to the country as a whole may still be unrecognized.

5. Thus the principal concern of the Department is not gain, but opportunity; opportunity for federal and provincial agencies to enact wise and effective legislation for the improvement of man's environment, opportunity for more profitable exploration on the land and in the sea, opportunity for private industry to take advantage of new mineral processes and applications, opportunity for the promising and ambitious to fulfill their dreams and aspirations and thus to add to the intellectual and physical wealth of the country, and opportunity to contribute to a research tradition for others to emulate and follow. The mineral wealth of the Canadian north will be made available to the nation through research leading to its discovery and exploration; indeed the only real hope for a northern economy depends on its minerals and fuels. The research now being initiated in the marine environment will surely lead, in the future, to our participation in the exploitation of the resources of the sea bed. And our competence in all fields in the earth sciences will enable our people not only to live more stimulating lives, but will enable them to offer help to less developed nations.

6. In the following pages the Department's statutory responsibilities and projects are described in some detail, along with an exposition of its research policies and practices. How well the scientists and administrators of the Department have succeeded in achieving their objectives will have to be assessed, in large measure, by those who come after them. The setting of objectives and the making of policies however, is a continuous, living process in which

all our institutions ought to share, and of which this presentation itself is an example.

A DEPARTMENTAL VIEW OF SCIENCE POLICY

The Reason for a Science Policy

7. In advanced countries there has been, during the last twenty-five years, a tremendous increase in scientific activities, there being now about ten times as many people engaged in research and development as there were before the war.[1] Expenditures devoted to these activities have risen even more steeply. Canada has participated in this surge of interest in science, and in the uses of science, the expenditures on research and development in Canada for the fiscal year 1966-67 being about 1.3 per cent of the gross national product. But much greater expenditures will be required in the years ahead if Canada is to keep pace with other countries belonging to the Organization for Economic Co-operation and Development (OECD) that are spending between two and three per cent of their gross national product on research and development.

8. These expenditures will be largely financed by government. All the signs indicate that this rapid rate of expansion in public spending will continue, as governments continue to seek ways of raising the standard of living, and of improving the quality of life of their people, for there is in principle no limit to opportunities for acquiring useful new knowledge through scientific research. We are already at the stage where scientific research competes for funds with schools, hospitals, roads, and so on, and the competition can only become keener in the future. The tax-payer and the politician are being forced to ask "Where are we going?"

9. To the proposal that scientific research should be limited, and directed toward specified objectives such as maximum economic returns, the traditional reply of the scientist has been that the search for knowledge must not be restricted; that the results of scientific research are unpredictable, and therefore decisions based

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(1) "The Allocation of Resources to Science", J. R. Gass, Deputy Director of Scientific Affairs, OECD. The OECD Observer, Special Issue on Science (1966).

on criteria other than those of the scientist himself will destroy the creative process of research.

10. These statements have validity when applied to fundamental research at the frontier of knowledge. But applied research, and development research, by their very nature, are directed toward specified objectives. The research is restricted in the sense that it is not permitted to wander too far from its goal; decisions as to its course are often based on economic returns, and if not, are based on some criterion other than mere curiosity; the scientist, in accepting an applied research project, accepts at the same time whatever constraints as to objectives that may be placed by his employer on his activities, his scientific freedom consisting in freedom as to how he works, and freedom to report his findings regardless of anyone's preconceived ideas.

11. Thus there is a recognition among scientists that there is nothing contrary to the spirit of science in attempting to direct applied scientific research and development toward specified ends. Since applied research and development are usually very much more costly than fundamental research, the way appears open, in principle at least, to ensure that the bulk of the funds that are made available by government for scientific research are expended in the pursuit of national goals. If this objective is to be achieved, scientific activities must be subject to some overall policy that is understood and accepted by the public, by politicians, and by scientists. Such a policy may be called a Science Policy.

Definition of Science Policy

12. Science policy was defined by Dr. O. M. Solandt, Chairman of the Science Council of Canada[1] as "a broad strategy for the use of science by the entire scientific community in support of national goals. These goals are economic and social." The important thing to notice in this definition is that science policy is not concerned only, or even primarily, with science itself, but with the use of

(1) "Proceedings of the Special Committee on Science Policy", p 47

science for the improvement of the wealth, health and cultural well-being of a people. Science and scientific research have an impact on economics, on defence and on education, and thus science influences almost every aspect of a nation's activities. This inter-relationship has led Dr. R. R. Nelson of the Rand Corporation to say that "for most decisions involving science, it is neither necessary nor helpful to have an overall science policy."[1] This may be an extreme view, but it illustrates the difficulties in developing a science policy, and the dangers inherent in taking too narrow a view.

13. In spite of the complexities of the subject, it is generally recognized that science can be broadly separated into pure or fundamental science on one hand, and applied science and technology on the other. In addition, four areas of scientific activity can be identified, namely universities, government departments or agencies, domestic industry, and international cooperation.

14. If in addition it is recognized that pure or fundamental science is pursued principally in universities, and applied science and technology principally in government departments and in industry, it appears to be possible to draw some general conclusions as to the direction a national science policy should take. Since applied science and technology usually require more financial support than pure or fundamental science, it will be convenient to consider the applied science field first.

Science Policy and Applied Science and Technology

15. Applied science and technology are supported by public funds in two major areas:

1. In the public sector, for example public health and national defence. It has become recognized that these are government responsibilities, and departments or agencies have been organized and financed to discharge the responsibilities. The departments or agencies have to conduct research to be effective, so government support of research necessarily follows.

(1) "Proceedings of the Special Committee on Science Policy", p 257.

2. In the private sector. The most common example is where government support is given an industry to assist it in conducting research in its own laboratories or works.

16. With respect to the public sector, it is important to note that when government appoints a department or agency to do something, it must also approve its right (indeed its obligation) to do the research necessary for it to achieve its mission. The department or agency has the responsibility of allocating its funds in various ways, among them being support for research. To deny a department or agency its power to control its funds is to deny the department or agency its ability to discharge its function.

17. The decisions of the department or agency as to the allocation of funds in support of research will depend on the department's or agency's estimate of the possibilities for productive research in its area of responsibility, on the general state of technology in its area of responsibility, and on the availability of appropriately trained scientists and engineers. Clearly the department or agency is, or should be, in the best position to make these estimates, and so to make the best use of the available resources.

18. An important question is "What checks should be exercised over departments and agencies with respect to their exploitation of research resources under their control?" Although this Department takes the view that decisions as to the allocation of funds for research in the pursuit of a mission should be the responsibility of the department or agency charged with the mission, this is not to be interpreted as a view that departments or agencies should be free of all checks over their research activities.

19. The problem is essentially one of obtaining adequate "feedback" as to the wisdom and effectiveness with which the funds are expended.

20. The first step in dealing with this problem would appear to be to have the department or agency define its mission, and to obtain for its definition the approval of government. With its mission defined, the conditions for an intelligent review of its

research activities will have been established.

21. This Department makes no claim to have developed the ideal system of obtaining "feedback" as to the effectiveness of its activities. However attention should be called to the system of National Advisory Committees, consisting of representatives from industry, from universities and from provincial governments, that meet regularly with senior officers from the branches to discuss current research in Canada in their respective fields, and the part this Department may play both through its own research programs and through the support it provides to research in other organizations. Specifically, the branches involved are Geological Survey Branch, Mines Branch, Observatories Branch, Marine Sciences Branch, Inland Waters Branch, and Surveys and Mapping Branch. Through this system, a continual monitoring of Departmental work is obtained from people who are knowledgeable in the areas concerned, and who, as both tax-payers and users of Departmental research, have a very real interest in the Department's activities. The reports that these National Advisory Committees prepare go to the Departmental Minister, and they thus serve the purpose of providing the political head of the Department with an independent assessment of the state of research in Canada, and of the contributions of his Department. Details concerning these Committees are set out in Appendix 1.

22. It is important to notice that this system works on the principle that it is the <u>products</u> of the Department's activities that are subjected to review. It is this Department's opinion that this system is superior to one in which checks and controls are applied to its <u>activities</u>, in that it places the responsibility for the effective use of its resources squarely upon the Department. The extension of this system would lead to fewer restrictive regulations from control agencies, and more acceptance of managerial responsibility by Departments.

23. It should be noted that the annual reports that are issued by all departments and agencies supported by public funds can in no way be regarded as a substitute for a face-to-face exchange of views

and ideas between knowledgeable people, such as the National Advisory Committee system provides. That the system also has a beneficial effect on the work of the branches will be obvious. It may not be so obvious, but it is a fact, that the system is well received by the branches; scientists and engineers invariably welcome opportunities to discuss their work with knowledgeable colleagues.

24. In the private sector it is normally clear that the research activity is in support of a mission, and the mission is normally well-defined. It is usual for government, having decided to support a particular research, to grant industry wide latitude as to how it prosecutes its projects, and to base its decision as to the extent and amount of support that is granted on an examination of the results that are expected or achieved. Thus, in the private sector, government now follows the principle that it is the <u>products</u> of an activity that are subjected to checks and controls, not the activities themselves.

<u>Science Policy and Pure or Fundamental Science</u>

25. This discussion has thus far been concerned with applied research and development. It is necessary now to consider fundamental research, which may be defined as research aimed at an extension of knowledge for its own sake, without direct preoccupation with the application of its results.[1] Fundamental research as so defined is international. Scientists in a particular country contribute pieces to the mosaic of knowledge, while scientists and technologists of any country are free to draw from the common pool of knowledge, and exploit it through technology. "Unless there is a considerable research effort and a deep understanding of the problems and techniques of fundamental research, a country will not possess a breadth and depth of scientific understanding to enable it to select from the world's store of knowledge those elements which are relevant for its develop-
ment.

(1) "Fundamental Research and the Policies of Governments". A. King, OECD Director for Scientific Affairs. The OECD Observer, Special Issue on Science, p 6 (1966).

(2) King, loc. cit.

26. It is generally recognized that such fundamental research and education reinforce each other, and that each is weakened if not fed by the other. Therefore, although the discipline and dedication that are associated with this sort of research will exercise their benefits wherever research of any kind is practised, the centre of gravity of fundamental research should lie in the universities, in close proximity to teaching.

27. Fundamental research, however, has an important place in industrial and government laboratories, where it is justified as essential to the industrial or government organization in order for it to carry out its mission effectively. Fundamental research should normally represent only a small part of the total effort of a mission-oriented organization, and should not be justified on the ground only that it satisfies the curiosity of the investigator. The application of this restriction will go far toward deciding what kind of research should be done by a given agency.

28. It has been proposed in this discussion that government support of applied research and development should be principally through industrial laboratories and works, and through mission-oriented departments or agencies, that will themselves guide the work in pathways consonant with national goals. Obviously this policy cannot be applied to fundamental research, if it is accepted that fundamental research should be centred principally in the universities, and that it should not have a direct preoccupation with the application of its results. Since it may be assumed that there will always be an insufficiency of funds for all the needs of fundamental research, some selectivity will be essential. It is generally agreed that it is important to support the right man, the man with ideas, leaving him free to follow his genius. The selection should be done either by, or with the advice of, a panel of scientists who can judge the competence of the scientist and the promise of his proposals. This is essentially the procedure now being followed in Canada.

Science Policy and International Cooperation

29. Up to this point this discussion has been concerned with the development and application of science policy toward scientific affairs within the country. However, there has always been an international aspect to scientific affairs. Up till twenty-five years ago international scientific projects were undertaken largely on the initiative and within the framework of scientific circles.(1) Today international scientific organizations such as the International Atomic Energy Agency (IAEC), the European Organization for Nuclear Research (CERN) and the European Atomic Energy Community (EURATOM) are promoted and financed by governments, and have annual budgets totalling hundreds of millions of dollars. In addition there are many inter-governmental activities being pursued, coordinated by organizations such as the International Joint Commission (on air and water pollution), the International Geophysical Year, and the Hydrologic Decade. Since there is every indication that these international scientific activities will grow in the future, there is a growing need for the country to develop, as part of its general science policy, an approach toward international scientific affairs.

30. The rapid expansion in international scientific co-operation reflects the increasing recognition of the power of science to influence favourably the economic well-being of a country, the fact that much of modern science requires resources in manpower, equipment and capital that are beyond the means of all but the wealthiest countries, and the fact that no country is an "island". No country that wishes to gain, or to hold, a position among the advanced nations of the world can stand aside from international scientific affairs, where decisions taken may have a bearing on its future competitive position in the economic and scientific sectors, and may thus affect its power and prestige.

31. It is clear that no country can determine, on its own, the course that international scientific activities will take. However, each country can determine the objectives it will set for itself in

(1) "Problems of International Cooperation in Scientific and Technical Research"; Jean-Jacques Salomon, OECD Observer, S!ecial Issue on Science, p 43 (1966).

entering international co-operative activities. That is to say, international co-operation should not be an end in itself, but rather the investment in money and other resources devoted to international activities should be related to the potentialities, needs, programs, and objectives of the participating country. Only on this basis can international co-operation in scientific affairs be meaningful and productive of maximum benefits to the participants.

32. The requirements for effective international cooperation in scientific activities has been summed up, as follows: "each country must:

1) envisage international actions in terms of an overall national science policy, and not as a series of unrelated ad hoc decisions;

2) be in possession of complete information on the whole of its participation in international co-operative schemes, and should therefore consult and co-ordinate the various national agencies concerned with different aspects of research;

3) consider participation in schemes of projects of international co-operation, when these would result in substantial extension or more effective use of national resources;

4) ensure that each scheme is designed to achieve its particular objectives as effectively as possible;

5) keep its international and national activity on the subject in balance so as to ensure that the progress achieved internationally is easily assimilated at national level."(1)

The Case for an Office of Scientific Affairs

33. The recognition of the costs to government of supporting scientific activities, of the power of scientific activities to influence the wealth and well-being of the people, and therefore of the necessity for the government to provide substantial support to scientific activities if its people are to remain among the advanced nations of the world, has led to the suggestion that a Ministry of Science be created and given supreme authority over the allocation of resources to scientific research, and the power to direct scientific research into those areas of greatest need. However, this proposal

(1) Jean-Jacques Salomon, loc. cit.

contains some serious disadvantages:

1. Departments and agencies, that were brought into being to pursue national goals, are in the best position to decide on the amount of their total resources that can wisely be devoted to research and development in support of their missions. A ministry of Science would necessarily be further removed from the areas of responsibility than the departments and agencies. The users of research are in the best position to say what research is appropriate at a given time.
2. There are dangers inherent in dividing the responsibility for the pursuit of national goals between a Ministry of Science, and other departments or agencies.
3. A Ministry of Science, large enough and complex enough to direct the scientific activities of a nation, would almost certainly develop into a bureaucratic organization that would be stifling to the very scientific inventiveness and initiative it was created to direct.(1)

34. Decisions as to the importance of different national goals, and as to the allocation of government funds among those goals, must be made however, and these decisions can only be made intelligently in the light of facts. Thus a case can be made for an Office of Scientific Affairs that will maintain statistics as to the amounts of funds allotted to the departments and agencies of government, to industries, to universities and to the support of international organizations, that are expended on scientific research. This information, combined with the requests for government funds in support of research from the various organizations, and examined in the light of the overall priority objectives of government, would provide the means by which government could give expression to a national science policy.

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(1) "Science, like economics, affects most areas of national life and national policy, so that most of the major departments of government will need their own science programmes, tailored to their own needs. The progress and freedom of science, moreover, have been best served historically in a pluralistic situation, and can suffer when co-ordination becomes control".
OECD Report "Science and the Policy of Governments" p 35 (1963).

35. It must not be imagined that through the implementation of a national science policy, it will be possible to find final and permanent solutions to any of the problems that will arise. The changing face of science and technology, and the changing needs of a country in relation to a changing world will make necessary a continual review of past decisions and continual review of projections for the future. There will be need for frequent and continuing contacts between politicians and scientists, and, while parliament represents the collective voice of politicians, means must be found for expressing the collective voice of the scientific community. As politicians in the exercise of their office are required to subordinate personal and local considerations, so scientists in offering advice on scientific matters will be required to subordinate their interests in specific projects in favour of the interests of the country as a whole. Statemanship will be required on both sides.

36. Finally it must be recognized by politicians, in whose hands the allocation of funds for scientific research finally rests, that scientific research cannot be turned on and off like a tap. It takes a period of years to develop a productive research organization, substantial sums of money to assemble equipment, and the research organization must be continually nourished with adequate funds, for change and growth are the essence of science. Thus politicians must recognize that the initiation of financial support for a scientific project carries with it a moral obligation to continue support over an extended period. For this reason, if for no other, governments should ensure that competent scientific advice is obtained, and a review of national objectives is made, before commitments to major projects are undertaken. Similar precautions should be taken before any change in emphasis in government support of areas of scientific work or research is made. Opportunity for public debate on the wisdom of the change should be afforded, and the scientific community should be given the opportunity to be heard. In this way the collective wisdom of the nation can be drawn into the decision-making process, and favourable conditions for the loyal support of the decisions made

will be established.

SCIENTIFIC ACTIVITIES OF THE DEPARTMENT

37. The scientific and technical work of the Department is conducted principally in the sectors and branches. The relationships between the Department as a whole, and the sectors and branches are shown in Figure 1. It will be seen that the Department consists of four sectors, those of Mines and Geosciences, Mineral Development, Water, and Energy Development. These sectors, with the exception of the Energy Development Sector, are divided into branches, each with its own special responsibilities. This organization reflects the role the Department plays in connection with all the non-biological resources of Canada.

38. The function of each branch (or in the case of the Energy Development Sector, of the Sector), together with a list of major programs under way during the fiscal year 1968-69, is set out in Appendix 2. It should be noted that programs are normally subdivided into related projects which are intended collectively to achieve some broad objective. Projects may have long or short lives, depending on a variety of factors; programs normally have continuing themes, and extend over years, being essentially the means whereby the work of the branches is given continuity. Short-lived programs of course occur, but this is not the usual case.

39. It should also be noted that, in accordance with the Guideline, the routine and continuous collection of data on natural and social phenomena, and the dissemination of scientific and technical information, are included as scientific activities. There are many scientific activities undertaken in the Department that do not involve scientific research. This is particularly true with respect to the Surveys and Mapping and Marine Sciences branches, for example. It is important this fact be kept in mind in reading the brief, as otherwise a greatly inflated impression of the research activities of the Department will be created, both with respect to number of programs,

and with respect to costs.

40. It may appear that there is an imbalance in the number of programs under way in the different branches. The reason for this is that the branches have various practices in the manner in which they group their projects into programs.

41. Appendix 2 also contains examples of research projects that have been conducted in the Department, five each of basic research projects, applied research projects, and development. In addition, a table showing the number of Departmental publications issued during the fiscal year 1967-68, and a list of patents that have arisen from Departmental activities, in force or being processed as of 31 March 1968, is provided.

42. An examination of the functions of the branches, of the programs under way in the Department, and of the examples of research and development projects, will show that this Department is strongly mission-oriented. The amount of basic research conducted in the Department is comparatively small, and what is done is invariably mission-oriented. This is clearly shown in the examples of basic research projects referred to above.

43. A discussion of the regional distribution of the Department's scientific activities, and of the regional impact of its activities, is presented in Appendix 3.

RESEARCH POLICIES AND PRACTICES

44. Departmental research policies are defined by the functions of the department and the branches, as set out in this brief. The particular programs, projects and goals are normally set by the branches, these being subject to review during the preparation of departmental estimates. This review has become more formalized and searching by the introduction of the Program Planning and Budgetting Review system.

45. Programs, projects and goals originate in three general ways:

1. As a result of an internal recognition of a need for knowledge for forward planning either by the Department, or by public or private organizations.
2. As a result of an agreement entered into by the Federal Government. Examples are work undertaken arising out of Canadian undertakings with respect to the International Joint Commission on Air and Water Pollution.
3. As a result of requests for advice or assistance from an outside source, such as another Federal department or agency, a provincial government, an association or group of companies, or even a single private company.

46. These represent the principal raw material from which, after examination in the light of branch and Departmental functions, of Departmental policies, the availability of suitable staff, equipment and funds, and the expertise and experience of Directors and senior officers, programs, projects and goals are developed.

47. Since no branch has the resources to conduct all the programs that are within its terms of reference, the selection of programs for support is an important process. Occasionally the process may be simple; programs necessary for the honoring of a specific commitment by the Federal Government will obviously be undertaken. More generally, program selection is a complex process, which takes at least the following points into consideration.

1) To what extent does the program serve the national interest?
2) Is the program consistent with Departmental and branch functions?
3) What are the probabilities of the program achieving its objective?
4) What will be the cost of the program, and how will it impinge, financially and technically, on other programs?
5) Is the program necessary for the honoring of existing arrangements, with other departments, agencies, or provincial governments?
6) Does the program have specific regional implications?
7) What would be the effect, economically and technically, of not undertaking the program, or of delaying it?
8) To what extent will the program advance the state-of-the-art?
9) Will future events tend to make the results of the program of more, or of less, importance than they now appear?
10) Could, or should, the program be undertaken by some other agency or organization?

It should cause no surprise if the attempt to optimize all these factors appears to have a large subjective content, rather than to be a purely objective process.

48. Attempts are continually being made within the Department to improve the objectivity of the process of program selection. The most familiar process is that of calculating cost-benefit ratios, and this process has been applied in some instances, notably by the Mining Research Centre of the Mines Branch. The Hydrologic Sciences Division of Inland Waters Branch has developed an equation involving twelve factors for use as an aid in selecting programs. However, cost-benefit analyses are difficult, if not impossible, to calculate for many Departmental activities because of the lengthy period that frequently follows the completion of the work, before its practical application Further, no monetary value can be assigned to work that promotes the health and well-being of Canadians by reducing air and water pollution, for example. Nor can a monetary value be placed on a geological map, which not only advises people where to look for valuable minerals, but also advises people where not to look.

49. The Department recognizes the need for program selection to be as thorough and as objective as possible, but it also recognizes the complexity of the process, and it expects to depend principally, for the foreseeable future at least, on the knowledge, expertise, and indeed the integrity of its senior officers for the selection of its programs, projects and goals, in the light of national needs.

50. The initiation of a program or project, once it has been selected, is primarily a branch responsibility. The circumstances under which the initiation occurs vary too widely to permit generalizations. No particular difficulties occur provided the program can be handled within the resources of the branch, and provided it is not necessary to involve any control agency of government. The general question of the relationship between a mission-oriented agency and a control agency is discussed later in this brief.

Program Monitoring

51. The introduction of the Program Planning and Budgeting System in the Department has encouraged a process of formal review of programs. However, the principal method of program monitoring is an on-going internal process. Programs are the subject of frequent discussions between representatives of different supervisory levels within the branches. Departmental staff both professional and non-professional, are sensitive to the interest their work arouses in visitors to their laboratories, to the acceptance it receives at technical meetings and elsewhere, and particularly to the use to which it is put in practical affairs; the vision of the scientist oblivious to his surroundings can be exaggerated. In addition, branch officers obtain a more formal evaluation of their work through the activities of the various National Advisory Committees that report to the Minister. These committees consist of representatives from industry, from universities and from provincial governments, and they meet periodically with branch officers to discuss national programs, the results obtained and the Department's role in such programs.

Program Priorities

52. The assigning of priorities to programs is clearly closely related to the process of program selection, combined with the on-going monitoring process that has been described. The problem of priority therefore needs no special mention, except to observe that research managers are unanimous that crash programs should be avoided as far as possible, as being expensive and inefficient. Unfortunately, this Department, because of its obligations to provide certain services such as those related to land surveys, is not always free to plan its work as it would desire. This is a matter of special concern to some branches, and the Department is continually examining ways to improve communication between the Department and other agencies.

Shifts of Research Resources

53. While crash programs are avoided where possible, a continuous shifting of research resources takes place within the Department. Projects that have achieved their objectives are terminated; those that depend for their success on results to be obtained from other projects are held in abeyance; some projects may have their objectives changed as a result of new insights into the problems involved. This Department however, being concerned with the renewable and non-renewable resources of the country, and with certain services essential to a people in advanced civilization, has its programs (of which its projects are a part) for the most part centred around continuing themes. Some programs, those related to mapping for example, continue because of the mere size of the country. Other programs, those related to the physical properties of metals for example, continue because of the frequent innovations that occur in the composition and fabrication of metals, and of the uses to which metals are put; when these programs have been chosen so that they are concerned with the basic rather than the superficial characteristics of metals, they find continuing themes. This evolutionary process is normal in a scientific and technical organization, and it presents no particular problems for the Department.

54. The Department recognizes that shifts of research resources, including personnel, are infrequent between branches, and probably less

frequent still between government departments, and has raised the question among its senior staff as to whether this situation reflects good forward planning, or an undesirable rigidity of habit. Indeed a national science policy should envisage the possibility of shifting research resources, including personnel, between industry, universities, and government, and should seek ways to make this process as uncomplicated, and as attractive to scientists and engineers, as possible. Fully portable pension schemes, comparable salaries and working conditions, and comparable standards of scientific and technical excellence, all these will promote the easy movement of technical people from one area of activity to another. This Department is of the opinion that the present barriers are small, and largely administrative, although the fact that most people do not like abrupt changes will always be a factor to be considered.

Contracting of Projects

55. The contracting of projects to industry or to universities offers a method of supplementing the research capability within the Department. There are a variety of reasons that may make the contracting of projects desirable:

1) It makes it possible for the Department to undertake special projects that are beyond its existing resources, without adding to its equipment or to its permanent staff.
2) It involves non-government personnel in government projects, and so promotes an understanding of government objectives among non-government people.
3) It promotes the dissemination of specialist skills in the country, rather than centering them in Ottawa.
4) It encourages research on problems considered by the Department to be of long-range importance to the country.
5) It ensures the development of the good research man, since the Department can select those to whom it will grant a contract.

Not all of these reasons may operate at the same time, but normally several will apply.

56. This Department has let twenty-two contracts for research and development projects during the last five years, the contracts being about evenly divided between industry, and universities and various institutes. About eighty per cent of the contracts have been in the water research sector, the balance being in the geological research sector. The Department has not formulated any general policy in the contracting of projects, since it is recognized that the needs of the branches differ, and that more diversified experience with contracts would be desirable before drawing final conclusions.

57. Although attractive arguments have been made for contracting projects, some senior Departmental officers have expressed reservations on the grounds that:

1) In some cases industry has accepted a contract for a project, but has had in the end to obtain most of its ideas from Departmental staff.
2) The scheduling of contract research in universities is uncertain, since so much depends on the graduate student involved.
3) Contracts to universities may divert the university staff from its primary role of teaching.

58. An alternative to the contracting of research to universities is to arrange for graduate students to do their graduate research in government laboratories under the direction of government scientists, with universities recognizing the work as part requirement for an advanced degree. This is commonly done in the Geological Survey Branch, and has been done in the Inland Waters Branch and the Mines Branch also. This practice places an additional responsibility on the Departmental technical staff, but apart from this, no exception can be taken to the practice, and indeed it has served the Department well in the field of geology particularly, contricuting both to the number of geologists available, and to the broader experience of those graduating.

59. It is clear that a variety of ways exist for supplementing Departmental resources, and that not all are equally desirable in all cases. However, all the ways that have been used are beneficial in

that they:

1) Offer the Department a way of expanding its resources temporarily.
2) Encourage the development of specialized skills in Canada.
3) Promote an acquaintance with the objectives and work of the Department throughout the country.

Measurement of Operational Effectiveness

60. The Department could present an impressive account of its accomplishments, but the challenge presented by the Senate Committee on Science Policy, that the Department discuss its effectiveness, is no small one. A major difficulty is that, even if a yardstick could be applied to the Department's output, there would remain the question as to whether the output could have been realized in less time, and with less expenditure. Thus the measurement of the Department's effectiveness is inherently difficult, and subject to more than one interpretation.

61. It is considered in this Department that the best indicator of its effectiveness is the acceptance of its programs, and the results of its programs, by national and international scientific organizations, and by the acceptance of its advice and work by those agencies and industries for whose benefit the work was undertaken. This amounts to the acceptance of the principle of the "judgment of peers", which has been adopted by the Public Service Commission as the means of judging scientific work.

62. The acceptance of Departmental programs and results is reflected by:

1) The number of its staff that are invited to act on national and international Committees.
2) The frequency with which Departmental publications are requested, the source of the requests, and the frequency with which the publications are cited.

3) The frequency and character of requests for advice or technical assistance, and the reactions from those requesting such advice or assistance.

4) The number of applications for patents, and the revenue earned therefrom.

5) Calculation of cost-benefit ratios resulting from the application of Departmental research.

None of these is a measure of the effectiveness of the activities of the Department, but over a period of years, statistics gathered under these heads would indicate whether its effectiveness was improving or otherwise.

63. Although the Department has not made a detailed study of the effectiveness of its activities, their effectiveness is in fact under continuous review, in the same sense that its programs are selected and monitored. The senior officers of each branch and division are sensitive to the effectiveness of their units in the terms that have been listed above, and by virtue of their professional contacts maintain a good knowledge of the effectiveness of similar units elsewhere. Whether these impressions can be made more precise is an absorbing question that the Department has currently under examination.

64. In attempting to measure effectiveness, one problem peculiar to government must not be overlooked. In industry, research is not normally undertaken unless it is intended to apply the results in the near future. The users of Departmental research are normally private individuals, companies, and universities, who may or may not apply the results of the research. In addition, Departmental research has more regard for the problems of the future than those of the immediate present. These considerations suggest that the effectiveness of Departmental research as measured by applications in specific cases would be misleading over the short term.

Forecast of Major Changes in Departmental Functions

65. No major changes in Departmental functions as defined earlier in this brief, are expected during the next five years. It is expected however that the Department will give increased attention to the

sociological aspects of mineral resource development. The problems presented to the Government by the declining gold mining and eastern coal mining industries, and the uncertainties that have developed in dealing with these problems, point to the need for planning in this area.

66. Not all studies will be devoted to problem areas. Although minerals are considered to be a classic example of non-renewable resources, research creates new resources by finding ways to recover a greater percentage of valuable material from an ore-body, by finding ways to treat lower grade ores economically thus in effect creating new ore reserves, and by developing substitutes for scarce materials from abundant materials. Thus the development of techniques for treating low-grade iron ores revolutionized the iron ore mining industry in a few years, creating vast new ore reserves; nickel is now extracted profitably from ores that were considered waste a few years ago; the western coal mines were able to capture Japanese markets through research into coking techniques. These developments have given rise to new communities, and have kept old communities alive. These fairly rapid shifts and changes in industrial activity product sociological problems that only careful planning and forecasting can minimize.

67. Two organizational changes that are foreseen during the next five years are:

1) Establishment of a West Coast Institute (the counterpart of the Bedford Institute in Dartmouth, N.S.) by Marine Sciences Branch, to serve as a base for the hydrographic operation on the Pacific and to undertake research in oceanography. As at the Bedford Institute, close collaboration is expected with universities and with other Federal agencies.
2) Establishment of a Hydraulics Division, by Inland Waters Branch.

These changes will not affect Departmental functions.

Major Problems in the Performance of Departmental Functions

68. This reference to major problems, or "major hindrances" to use the terminology used in the Guideline prepared by the Senate Committee on Science Policy, should not lead to the inference that the work of the Department is in danger of being brought to a halt. Nonetheless, senior officers of this Department are satisfied that the items referred to below have a substantial adverse effect on the efficiency with which their organizations can achieve their objectives.

1. It is considered that the job classification procedures, which have consumed much time and energy of personnel officers, of technical staff and of supervisors, and which are still far from complete, have only served to introduce undesirable rigidity into the public service by making it difficult to reward particular skills and expertise that are needed if the organization is to achieve its objectives effectively. This is a serious shortcoming in the Department, particularly where work has to be done under challenging conditions at sea or in the arctic, and where the prime consideration is not paper qualifications, but whether a man can do the job required, and whether he can be depended on.

   In a mission-oriented organization, the ability and willingness of a person to contribute to the achieving of the mission by accepting and discharging assignments designed to that end should be the most important considerations in defining his place in the organizational structure. It follows that regulations regarding personnel should be as flexible as possible, and that mission-oriented departments should have the maximum possible amount of control, particularly over hiring, reclassification, and promotions in scientific and technical positions. That more decentralization of personnel administration is possible in government is shown by the relative freedom that is enjoyed by those government agencies that

are not under the aegis of the Public Service Commission.

It is essential, particularly in a research and development situation, that all staff members, senior and junior, professional and non-professional, be committed to their tasks if any real progress is to be made, and the Department has recognized the necessity of this by introducing a system of participative management into its operations at considerable expense both in time and money. However, the concern of Treasury Board and the Public Service Commission appears to be principally with job classification procedures, and they have required the staff of this Department to become heavily involved in such procedures. The unfortunate effect is to encourage personnel to relate themselves to an artificial system controlled from outside the Department, rather than to the tasks that have to be done, and to the colleagues with whom they work.

2. The circumstances under which grievances have arisen in the Department have led some senior Departmental officers to the opinion that the introduction of collective bargaining by groups in the scientific and technical public service is tending to introduce a rivalry between groups as to which can drive the best bargain, and to make group members more intent on preserving the rights they have won, than in bringing the projects they are involved in to a successful conclusion.

3. No adequate provision exists in the personnel structure for adequate staff support for senior officers, particularly those who have managerial responsibilities. The consequence is that officers whose real interest is in scientific work have frequently to be impressed into staff work, and senior officers are deprived of the kind of continuous assistance that would free there minds of detail, and permit them to fulfil their proper function of managing.

4. A situation of well-recognized complexity exists in all matters concerning natural resources. Although the provinces control the natural resources within their own borders, the Federal Government is active in these areas, and has obvious national responsibilities. Considering the intimate nature of the co-operation that has existed over the years, it is remarkable that few serious difficulties have arisen. However, misunderstandings have occurred, particularly with regard to Federal Government activities concerned with water.

At present, where a provincial government requests Federal Government assistance in the resource area, two policies exist within this Department, both having developed over the years on an "ad hoc" basis, and both defensible:

(a) The Department may carry out the request, providing staff, equipment and funds. This occurs for example where requests for control surveys are received from a province, and for geological surveys in Newfoundland and British Columbia, where the Federal Government has a specific commitment under the terms of confederation.

(b) The Department may provide advice only, requiring that local competence be developed to do the necessary work. This occurs for example where requests for technical assistance in connection with the control of pollution of inland waters are received.

It seems inevitable that, as both Federal and provincial budgets come under closer and closer scrutiny, the question as to "who will provide what" will become increasingly urgent, and it will become mandatory that a general policy covering Federal and provincial co-operation in matters affecting resources be developed.

5. It happens periodically that the government considers it has over extended itself with respect to expenditures, and a cutback of departmental budgets is initiated. In the opinion of this Department the savings effected by such measures are small compared with the wastes of talent and of existing resources that result, for the savings are invariably effected by reducing operating costs rather than overhead costs. True, the savings are visible and the wastes are invisible, but this does not justify the practice. The owner of a racehorse does not attempt to recover his expenditures by economizing on oats.

6. The Department's relations with the control agencies of government will be described later. Here we will only consider certain problems which occur in this area. It is normal for departmental officers to chafe under the restrictions that are applied by the control agencies, even though everyone recognizes that control of some kind must exist. It is worth considering, however, whether the controls that are in fact applied lead to the most effective use of the resources of people and money that are involved. Both the Department and the control agencies have their missions to fulfill, but it sometimes appears that difficulties arise because their respective missions are not entirely compatible.

For example, what is the most effective use of computers and computer services? (This example is taken for illustration only, and has no necessary relation to the real situation existing with regard to computers). For a control agency, concerned with efficiency in the use of resources applied to computers, the answer will be to obtain the most computers and computer services per dollar expended. But for a mission-oriented Department

the answer may be different, for the Department must seek the most effective use of all its resources, not concentrating on any one. Further, the Department has set itself goals and schedules, and it must consider the consequences of failing to meet them. Under these circumstances, conflicts of opinion are inevitable, and such conflicts are not the result of incompetence or intransigence on either side, but arise in fact from the dedication of each organization to its mission.

It would appear that, once spending authority has been granted to a mission-oriented department, the control over the spending should also lie with the department, the control being exercised through the line officers. Agencies having special interests, and hence special knowledge, should be available to line officers as advisors, so that line officers may have the most complete information possible on which to base decisions. This arrangement would encourage cooperation rather than conflict between various agencies of government, with the objective of achieving the most effective use of all available resources to achieve defined goals.

69. Present arrangements, under which a department has to conform to the requirements of a number of control agencies which have limited understanding of, or responsibility for, departmental objectives, leaves little room for a department to exercise responsible management of its affairs.

Use of Network Methods in Controlling Projects

70. Network methods, such as PERT or Critical Path, are not considered to be generally applicable to the research aspects of a project, since it is inherent in research that one is breaking new ground, with each step depending critically on its predecessors. Network methods do have application however in controlling programs that depend for completion on a number of factors that are well enough

understood to permit realistic scheduling. Current or recent examples of their use in the Department are:

1) By Inland Waters Branch, for planning projects for implementation during the International Field Year, 1970-71.
2) By Inland Waters Branch, in planning for the Canada Centre for Inland Waters.
3) By Inland Waters Branch for planning and executing a major operational project in groundwater hydrology, involving the cooperation of a n umber of federal and provincial agencies.
4) By Mines Branch, in planning a stope support project to co-ordinate the work of a mining company, a drilling contractor, and Mines Branch.
5) By Mines Branch, in planning the construction of a highly instrumented smelting furnace installation.
6) By Mineral Resources Branch, in planning the preparation and production of certain major reports.

The Transfer of Research Results to Those Having Potential Need for Them

71. The principal means of transfer of research results is through publications which provide a permanent record of the work of the Department. Publications may be in the form of reports prepared in the branches, and published as a series by the Queen's Printer. Thus the Geological Survey Branch, Mines Branch and Mineral Resources Branch issue series of reports dealing with their specialties. Some of these reports appear in abstract form in one or more of the publications that provide an abstracting service, and so receive wide publicity. This is supplemented however by a notification service, by means of which persons and organizations, including libraries, interested in the work of the Department are notified by post card of new publications as they become available. In addition, annual indexes of the publications issued by these branches are published. The Geological Survey Branch operates a system whereby persons can have access to geological maps and reports

before they have been finally readied for publication; interested persons can arrange to be notified as to the availability of such material. The Mines Branch publishes an annual Mines Memo, which contains a summary of the work of the Branch for the previous calendar year; this report is directed toward the knowledgeable technical reader rather than the specialist.

72. Publications may also be in the form of scientific and technical papers which appear either in the specialist journals, the general technical literature, or as articles for newspapers such as the Northern Miner. Scientific and technical papers are abstracted by the regular abstracting services, and so receive world-wide distribution.

73. The Department's publications include the results of both intramural and extramural contract work impartially. The results of extramural work done with the assistance of grants provided by the Department are of course published, normally in the form of scientific and technical papers, by those to whom the grants were made.

74. It is well recognized that, in the flood of technical literature now being produced, the significances of the written word may be overlooked even by the knowledgeable and discerning reader. This is one reason why the Department supports its scientific staff in attending conferences and committee meetings of various kinds, where personal contact can ensure that relevant information is passed to those to whom it is important. Personal contact with people who have use for information available from the Department is also ensured through co-operative industry-government organizations such as the Canadian Mineral Processors, the Steel Castings Institute, and similar organizations in which Mines Branch staff are active, and special meetings such as the Map Users Conference organized by Surveys and Mapping Branch. In addition, the National Advisory Committees, consisting of persons from industry, from universities and from the Department, that meet regularly with representatives from the Marine Sciences Branch, the Inland Waters Branch, the Geological Survey Branch, the Observatories Branch, the Mines Branch and the Surveys and Mapping

Branch, serve to keep interested Canadians aware of the nature of the programs under way in the Department.

75. All of these activities are supplemented by a substantial correspondence that is handled by the Departmental staff on the widest variety of technical matters, and a stream of visitors to Departmental laboratories coming from all parts of Canada and many parts of the world, of which no organized record is kept.

THE MISSION, ORGANIZATION, AND AFFILIATIONS OF THE DEPARTMENT

DEPARTMENTAL MISSION

76. The mission of the Department and the mandate for its various activities are based upon the Government Organization Act 1966, and the Resources and Technical Surveys Act. Relevant portions of these acts are presented in Appendix 4, together with excerpts from a letter in 1966 by the Prime Minister to the Minister of Energy, Mines and Resources discussing the role of the new department. This is followed by a discussion of the Department's role in relation to the legislation. In summary the principal elements of the mission are:

1. The development, through data-gathering and research, policy formation and planning, and the coordination of national effort, of a sound basis for the exploitation and management of
   (a) mineral and other non-renewable resources,
   (b) water and renewable resources,
   (c) energy resources.
2. The provision of certain services to the nation such as
   (a) surveying and mapping, both terrestrial and hydrographic
   (b) maintenance of a time standard,
   (c) compilation and publication of a variety of records and statistics on mineral production, stream flow, navigational information, etc.
3. The discharging of certain phases of the Federal Government's responsibilities for
   (a) the administration, coordination and management of energy, mineral, and water resources and of projects relating to these,
   (b) the subvention and distribution of Federal funds for projects and industries in these fields.

The first two of these functions comprise activities of a scientific nature according to the definitions established for this enquiry; the third in general does not, except where the funds distributed are in support of scientific activities.

77. A sound policy for the management of resources must be based on information which includes:

(a) an inventory of known resources,

(b) an understanding of the factors that determine the occurrence or generation of these resources,

(c) intelligent forecasts of the demand and markets for the basic materials and their products,

(d) knowledge of the techniques involved in exploiting the resource, and appreciation of potential new developments.

78. The Department has been authorized to obtain this information through a wide range of surveys and research, and is thus the earth sciences agency of the Federal Government. Its programs cover a broad spectrum ranging through fundamental investigations of our natural resources and their environments, applied research on methods of finding and extracting resources, economic research on markets and potential demands, and interdisciplinary studies leading to the development of policies and plans for resource management.

79. Most of the research activities of the Department in the natural sciences, with the exception of some phases of water research, have been well developed for many years. Its various functions of policy development, co-ordination, and management in the fields of energy, water, and renewable resources, were added at the time of the reorganization in 1966. This combination of scientific and policy-forming activities gives the Department a unique competence in the fields of earth sciences and non-biological resources.

80. The data obtained by such activities as geodetic, topographic, hydrographic, and hydrologic surveys are necessary for the scientific studies, and are therefore classed as "scientific data" for the purposes of this report, but the Department's responsibility for obtaining them constitutes a basically non-scientific mission. Even if there were no research studies by the Department, all of these activities would need to be undertaken because of their importance for other phases of national life: economic, social, military, or cultural. It is important that this distinction be emphasized since the essential character of these services should not be obscured by considerations specifically

concerned with research policies, and conversely the effort attributed to research should not be inflated by the inclusion of "data-gathering" activities, even though they are conveniently combined with the research effort in the one department.

81. Nevertheless the advantages of this combination should also be emphasized. It has been shown both in this department and elsewhere that the vitality of the data-gathering group is stimulated by collaboration with the users of their data. Deliberate efforts are being made to integrate the operations of scientists and surveyors wherever this will result in either economy of operation or a broadening of interest for the personnel involved. Both groups become part of a team which has goals in which all the participants can identify themselves.

DEPARTMENTAL ORGANIZATION

82. The Department is divided into four sectors, each under an assistant deputy minister. These encompass the principal spheres of interest, although the division of responsibilities and activities is somewhat uneven at the present time. The departmental organization is outlined schematically in Figure 1.

83. The scientific work the Department cuts across all four sectors, although all the research in the "natural" sciences is done in the Water and the Mines and Geosciences sectors, while the socio-economic studies (including geography) are done in all four sectors. At the present time the natural sciences represent a very much larger effort, whether measured in men or in money, than do the social sciences.

84. After the new department was brought into being in 1966, a great deal of thought was given to the relative merits of two types of organization. On one hand was the concept of an "earth sciences institute" (perhaps after the pattern of NRC) which would comprise all the natural science activities and be essentially independent of the policy development, advisory, and administrative roles of the Department. There is still a substantial body of opinion in the Department which favors this concept. The alternative structure, which has been adopted, was based on the proposition that the total mission of the Department

could best be fulfilled if all functions concerned with a given field or resource were combined under a single management. The Water Sector, which has been the area of greatest growth since the reorganization, combines the natural scientists, surveyors, engineers, geographers, economists, planners, and administrators who are concerned with water and renewable resources. Thus an integrated approach is being sought for the planning of both research programs and policy development. Combining the various functions in this way should tend to emphasize the mission-orientation of all phases of the work.

85. Support services at the departmental level generally come under the Senior Advisor (Finance and Administration) and the Senior Advisor (Personnel). Corresponding support staffs in the sectors and branches are generally responsible to the head of the operating unit in which they work (e.g. a branch) and derive functional advice from senior personnel in the corresponding headquarters staff. The divisions comprised within each of the branches are listed in Table 1.

86. The distribution of authority within all the branches is similar with the exception of the Marine Sciences Branch. All the other branches are divided into roughly equivalent divisions, each of which is under the management of a "chief" who answers for his division to the branch director. Where a division is located elsewhere than in Ottawa (the Great Lakes Division at Burlington, Ontario, and the Institute of Sedimentary and Petroleum Geology at Calgary, Alberta) the chief and his staff remain in the same relationships to the rest of their respective branch as if they were in Ottawa. The Marine Sciences Branch, on the other hand, has adopted a regional organization in which operational responsibilities come under three regional directors, while at headquarters senior specialists in each of the major branch functions serve as advisors to the branch director and regional directors on matters concerning their specialties. This type of organization lends itself most clearly to a branch such as Marine Sciences, which necessarily concentrates its activities in areas remote from Ottawa, but is being considered for the other branches having regional institutes.

87. Organization charts for Marine Sciences Branch, and for the Geological Survey Branch (this last representing the more usual branch organization) are presented in Figures 2 and 3.

Studies of Departmental Organization and Procedures

88. In order to improve efficiency, twelve studies of the organization and procedures of this Department and its predecessor, the Department of Mines and Technical Surveys, have been made during the last five years. These are described briefly in Appendix 6.

RELATIONS WITH GOVERNMENT AND CONTROL AGENCIES

89. The Minister of Energy, Mines and Resources, as head of the Department, is the link between Cabinet, the governmental executive body, and this one of its operational arms. In principle the Minister states government policy for the Department, and in turn speaks on behalf of the Department when national priorities are being established.

90. Treasury Board has been the control agency that enforced policy decisions by allocating the money and limiting the positions available to the Department as a whole and in many cases by specifying their distribution to the groups and programs within it. In these respects this department probably differs little from other departments and most agencies of the Federal Government, especially those whose operations involve a broad range of esoteric skills. Operational decisions, within these limitations, are of course made by the managers and professional employees who make up the Senior Staff.

The Public Service Commission and the Bureau of Classification Review

91. Traditionally the Public Service Commission and its predecessor the Civil Service Commission have handled all hiring, with the exception of casual (i.e. temporary) and certain hourly-paid categories. Recently the Commission has begun to delegate some of the responsibility for hiring, and the Department now conducts its own competitions in limited areas, under rules which have been laid down by the Public Service Commission. Policies and regulations governing the classification and promotion of individuals are also established by the Commission, which monitors the procedures of all departments in these respects.

92. The classification of positions, as distinct from the incumbents or applicants for them, is done by the Bureau of Classification Review, an agency of Treasury Board. All positions on the Departmental establishment list have been, or are being, classified by the Bureau.

RELATIONS WITH OTHER OPERATIONAL AND SCIENTIFIC AGENCIES

National Advisory Committees

93. In order to maintain close liaison between the staff of the Department and the most interested and informed groups in the country, six national advisory committees have been established, each concerned with a major Departmental activity. Each committee comprises representatives of universities, industry, provincial governments, other Federal departments, and one or more senior officers of this department. In most cases the activity with which the committee is concerned is within the purview of a single branch, although this is not necessarily the case. Membership is by Ministerial appointment and incumbents are compensated only for expenses incurred.

94. These committees with their terms of reference are described in Appendix 1, and their value to the Department has been discussed in Section 2. Here it will be sufficient to say that they serve the dual purpose of recommending programs which are in the national interest

and of acquainting the community with the activities of the Department. They also review applications for grants-in-aid of research and recommend the disbursement of funds for this purpose. The six committees are:

The National Advisory Committee on Research in the Geological Sciences

The National Advisory Committee on Geographical Research

The National Advisory Committee on Astronomy

The National Advisory Committee on Control Surveys and Mapping

The National Advisory Committee on Water Resources Research

The National Advisory Committee on Mining and Metallurgical Research

Interdepartmental and Interagency Committees

95. The Department is also represented on a number of committees of a scientific or quasi-scientific nature whose primary concern is not necessarily with programs of this Department. The functions of these committees range from the exchange of information through program coordination to the recommendation of policy. Representation is normally by an officer of sufficient seniority to speak authoritatively on the matter which is under the purview of the committee. A list of interdepartmental and interagency committees is presented in Appendix 5.

International Committees and Agencies

96. Departmental involvement in the work of an international committee or agency can be in any one of three ways: by direct official representation, by service as advisor to the official Canadian delegate, or simply by the contribution of information or data on a continuing basis to an agency which provides a common service. A list of such involvements is given in Appendix 4. Many employees of the Department also serve as individual members on international committees and as executives of international associations, governmental as well as intergovernmental. Systematic records have not been kept of this type of participation, but the number of individuals involved is substantial, a fact that indicates the international recognition accorded to many of the scientists and engineers on the staff of the Department.

PERSONNEL POLICIES

Recruiting and Evaluation

97. It is a truism that the work of the Department depends ultimately upon the activities of its personnel. This Department, because of the large scientific and technical content of its work, is particularly sensitive to the characteristics of its staff. Scientific and technical work is of value in proportion to the element of creativity that is injected into it. However, creativity, although it can be directed and to some extent promoted, cannot be brought into being by legislation. Thus it is of the greatest importance to the Department that creative people are recruited, and, having been recruited, that they be placed in positions where their creativity will have the most favourable effect on the activities of the Department.

98. The points discussed in the following paragraphs were raised in the Guideline, and are discussed in the order in which they were raised.

99. Potential researchers are identified from among the university graduating classes and hired by the following means:

1. University recruitment is co-ordinated by the Public Service Commission. Booklets are prepared which describe the scientific work carried out by the Department and the career opportunities for graduates in the various disciplines. They mention the university recruitment program and invite applications for interview. The booklets are sent to the various universities. Recruitment teams visit the universities each year during November, December and January. Each team includes a Public Service Commission representative and one or more good scientists. The visit is well advertised and the team interviews qualified students, interested in employment. The team discusses the job opportunities with the students and assesses their potential for scientific work. The results of the interviews are recorded. Selection for employment is finally made based on the results of the interview,

recommendations from the professors, course content, academic standing, interests and previous work experience, especially in the research field.

2. The work performance of undergraduate and graduate students employed on Departmental scientific work for the summer is carefully observed. Those with research potential are encouraged to continue with graduate study and to apply for full-time employment on completion.
3. In some cases, Departmental scientists contact well-known university professors, with whom they are acquainted or who work in fields parallel to their own, and ask for their recommendations concerning potential scientists. Those recommended are invited to apply for employment and are interviewed by a recruitment team. Such contacts are frequently made at scientific meetings and conferences.

100. The identification of potential research scientists involves a substantial element of judgment, for the brilliant undergraduate does not always make the best research man; the slow starter may eventually develop the more penetrating insight. Where judgment is involved, it is obviously important to obtain a variety of points of view. In this Department, the following criteria are employed to identify research scientists with potential:

1. The quality of previous research work, for graduates at the Master's and Ph.D. levels.
2. Recommendations from professors and previous employers.
3. Course content, academic standing, previous work experience and interests, as indicated through hobbies, etc.
4. An assessment of research potential made by the interview team.

101. Research administrators play an important role in a large scientific and technical department, and their identification and development is an important aspect of personnel policy. Research managers continually review the characteristics of their research staff,

to identify individuals with administrative potential. The Departmental Scientists' Appraisal Committee reviews all research scientists each year, with a view to evaluating scientific productivity and identifying potential research administrators. Outstanding research scientists with interests and abilities in research administration are guided into this type of work.

102. Research administrators and research scientists have more or less parallel but equal ladders for salary increases and promotions. The grade for research administration positions is determined by the Bureau of Classification Division, whereas the grade for research scientists is determined by the Scientists' Appraisal Committee. The in-grade salary increments for both groups are determined through the Appraisal Committees. The research scientist can be granted a salary increment commensurate with his research productivity, whereas the research administrator can be granted a number of increments in the pay range for the grade; both within the conditions set by Treasury Board. Theoretically, the Research Scientist 4 grade has no top salary limit, but in practice it normally does not extend beyond the maximum salary for the Research Manager 3 grade of $24,100.

103. With respect to the intramural and extramural education for staff members conducting and administering research, intramural education for research scientists is provided on-the-job, working with experienced staff. The scientists have available the latest technical literature and up-to-date equipment, and attend in-house seminars and outside scientific conferences.

104. Extramural education is provided to promising research scientists by granting university leave, normally with an allowance equivalent to half pay, plus payment of tuition and travel expenses. Applications for educational leave are approved by the Departmental Educational Leave Committee and by Treasury Board.

105. Research administrators are encouraged to take courses in management theory and practices. These are given by the Departmental Training and Development Section, the Public Service Commission and outside institutions.

106. In view of the important role that research administrators (more commonly called research managers) play in large scientific and technical organizations, some observations on their selection and development may be appropriate.

107. Many descriptions of the duties and responsibilities of a manager have been written, but in essence they can be reduced to five:

1. Deciding what are the right things to do.
2. Bringing the available resources of personnel and material to bear on the things to be done.
3. Obtaining the personal commitment of the entire staff towards getting the right things done.
4. Reviewing and up-dating planned actions, to ensure that intermediate and terminal objectives are met.
5. Devising criteria for measuring results.

These items constitute one description of the managerial functions.

108. It should be noted that this description would fit the job of a corporation president, a marketing supervisor, or a machine shop foreman, just as well as that of a research manager. True, the research manager's goals are specialized, but so are those of an accountant. His people are specialized from the standpoint of training and perhaps temperament, but so are those supervised by a city editor. His facilities and tools are specialized, but so are those of a paper mill superintendent. His problems in predicting results from a given action are specialized, but so are those of an advertising vice president.(1)

109. It must be concluded that research managers can be selected and developed using the same techniques that are used for the selection and development of managers for any purpose whatsoever. Research managers must however have had extensive personal experience in research, for without this experience, communication between the manager and his staff will be impaired, and the manager will not be an effective leader.

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(1) Bradley, W. E., Research Management, Vol X1, No. 3, p 167 (1968).

Training and Development of Public Servants Engaged in Scientific Occupations

110. A laudable concern is exhibited throughout the government service as to the qualifications and demonstrated ability of candidates for scientific and technical positions, both professional and non-professional, in the public service. However, in general much less concern is shown as to whether employees in the public service endeavour to improve their qualifications, either for the purpose of obtaining additional degrees or certificates, or simply to keep up-to-date in a rapidly changing scientific and technical environment. If it is important that recruits to the public service be scientifically and technically competent, it should be equally important that they remain so, and if possible increase their competence. Indeed there are advantages for an employer in expending money on the education of persons who have been in his employ for a period, for their immediate supervisors will know on whom such an investment will be worthwhile.

111. Under existing regulations almost any type of training useful to the Department can be obtained by an employee and some degree of financial assistance will be provided. However, the existing regulations have been developed on an ad hoc basis over the years, and have not been consolidated into a framework which will clearly show the employee what can be done, how it can be done, and who does what. This omission does nothing to stimulate the employee toward making the sacrifices of time and energy that any worthwhile course will demand. Further, a regulation that stipulates that a technician must pay his own tuition fee of (say) $30.00 to take a course at night school, and buy his own books, on the understanding that if he passes his final examination, he will be reimbursed to the tune of $15.00, is not one to convince an employee that his employer is serious about post-employment technical training, no matter what his supervisors may say.

112. In a scientific and technical department the close relationship between education and productivity does not need to be argued. This Department is of the opinion that government should adopt a more positive attitude toward the continuing education of its employees.

Specifically, more encouragement should be given to employees who wish to pursue education in those fields where recruitment is difficult, the concern over the recovery by government of picayune amounts of money from employees should be abandoned, and the regulations covering employee training should be simplified and made available in the form of a booklet.

Personnel Engaged in Scientific Activities

113. It was requested in the Guideline that specific information regarding personnel engaged in scientific activities be provided. This information is given in Tables 3 to 22.

EXPENDITURES ASSOCIATED WITH SCIENTIFIC ACTIVITIES

114. Departmental expenditures on scientific activities have been broken down into the categories suggested in the Guideline. The details are presented in Tables 23 to 26.

115. The following functions, scientific disciplines and areas of application have been identified:

1. Functions: intramural R and D, data collection, scientific information, testing and standardization, support of R and D in industry, support of R and D in universities. The data show that the primary function of the Department is intramural R and D, accounting for approximately 50% of the expenditures on scientific activities, followed by data collection, which accounts for approximately 35%. See Table 22.
2. Scientific disciplines: engineering and technology, natural sciences (agricultural sciences, astronomy, atmospheric sciences, biological sciences, chemistry, mathematics, oceanography, physics, solid earth sciences), social sciences (demography, economics). The data show that the principal scientific discipline in the Department is solid earth sciences, accounting for approximately 40% of the expenditures on scientific activities, followed by oceanography, which accounts for approximately 30%. Note that oceanography here includes all of hydrography, the preparation of nautical charts, and limnology (the study of lakes). See Table 23.
3. Areas of application: nuclear energy, space travel and communications, war and defence, agriculture (including fisheries and forestry), construction, transportation, telecommunications, industry, economic and fiscal policy, regional development, other (development and management of resources, development of water resources, development of energy resources, astronomy and

geophysics). The data show that the principal area of application of the Department's work is in industry, accounting for approximately 30% of the expenditures, followed by the development of water resources, accounting for approximately 25%. See Table 24.

116. A review of the figures presented in the tables shows, as perhaps the principal item of interest, the rapid growth of expenditures on fresh water resources which followed the establishment of the Inland Waters Branch and the Policy and Planning Branch in 1965-66. The expenditures increased by a factor of about 4 from 1965-66 to 1968-69. Table 25 shows that expenditure associated with the renewable (water) resources Sector of the Department increased from 22.3% of the expenditures on scientific activities of the Department in 1962-63 to 44.0% in 1968-69. The table also shows that the proportion of the total expenditures on renewable resources devoted to intramural R and D increased from 10.1% to 32.6% over the same period.

117. Other noteworthy items in Table 23 are the appearance of agricultural science as a discipline in 1967-68 (in connection with the use of vegetation as an indicator of minerals and groundwater), the appearance of mathematics as a separate discipline in 1968-69, and the increase of expenditures on economics by a factor of about 3 from 1967-68 to 1968-69.

118. Table 26 shows the operating and capital funds expended by those branches responsible for scientific activities, from 1962-63 to 1968-69.

APPENDIX 1

NATIONAL ADVISORY COMMITTEES

The six National Advisory Committees associated directly with the work of this department are listed below, as well as the branches with which they are most directly concerned:

National Advisory Committee on	Branches	
	Primary Concern	Secondary Concern
Research in the Geological Sciences	Geological Survey	Marine Sciences Inland Waters
Geographical Research	Policy & Planning	Surveys & Mapping
Astronomy	Observatories	
Control Surveys & Mapping	Surveys & Mapping	
Water Resources Research	Inland Waters	Policy & Planning
Mining or Metallurgical Research	Mines	

All the Committees have in common the following:

1. Members are appointed by the Minister on the recommendation of the Deputy Minister.
2. Members are compensated for expenses incurred but otherwise serve without remuneration.
3. Each committee reviews all applications for grants-in-aid of research in its particular field of competence and recommends the allocation of funds by the Department for this purpose.

The additional main points of their individual terms of reference are as follows:

National Advisory Committee on Research in the Geological Sciences

The Committee shall:

(a) coordinate geological research in Canada;

(b) suggest research projects that should receive attention; and

(c) aid, insofar as possible, in having problems undertaken by qualified personnel and in securing finances where needed.

The membership consists of:

(a) up to six members representing Provincial Governments and Research Councils;

(b) up to ten members representing Canadian universities;

(c) up to four members representing the Canadian mineral industry;

(d) up to two members representing the Geological Survey of Canada; and

(e) an officer of the Geological Survey of Canada who shall act as Secretary of the Committee.

Notwithstanding the foregoing, the Minister may make such changes in the membership of the Committee as he deems expedient to the work of the Committee.

National Advisory Committee on Geographical Research

The Committee

(a) provides continuing advice to the Minister on needs and priorities for geographical research in Canada;

(b) assists in the coordination of geographical research in Canada; and

(c) promotes the development of geographical research and makes recommendations on applications for grants-in-aid of such research.

The membership consists of:

(a) an Assistant Deputy Minister of the Department;

(b) up to six members from federal and provincial government departments, agencies and research councils;

(c) up to ten members from Canadian universities; and

(d) up to four members from Canadian industrial and business establishments and associations.

The Chairman of the Committee is a senior officer of the Department appointed by the Minister.

National Advisory Committee on Astronomy

The Committee advises the Minister on:

(a) all aspects of astronomical research in the Department;

(b) the coordination of the federal astronomical program with that in the several Canadian universities; and

(c) the methods by which astronomical research and teaching may be stimulated within Canadian universities.

The membership consists of:

(a) A chairman, who is a senior officer of the Department, appointed as such by the Minister on the recommendation of the Deputy Minister;

(b) up to eight representatives of the departments or agencies of the Government of Canada involved in astronomy;

(c) up to eight representatives of Canadian universities; and

(d) any individual scientists the Minister may designate, because of special circumstances.

National Advisory Committee on Control Surveys and Mapping

The Committee provides advice to the Director, Surveys and Mapping Branch on:

(a) the coordination of federal surveying and mapping programs; and

(b) the promotion and coordination of related research and educational programs, including the sponsorship of worthy research projects.

The membership consists of:

(a) a Chairman, who is a senior officer of the Department, appointed as such by the Minister on the recommendation of the Deputy Minister;

(b) a representative of the Department of National Defence;

(c) up to three representatives from other departments or agencies of the Government of Canada;

(d) up to two representatives from Governments of the provinces of Canada;

(e) up to two representatives from Canadian universities; and

(f) up to two representatives from industry.

National Advisory Committee on Water Resources Research

The Committee

(a) providescontinuing advice to the Minister on needs and priorities for research on water resources in Canada;

(b) assists in the coordination of water resources research in Canada; and

The membership consists of:

(a) the Assistant Deputy Minister (Water) and the Directors of the Policy and Planning Branch and Inland Waters Branch;

(b) up to ten members from other federal agencies; and

(c) up to ten members from Canadian universities, provincial and other bodies.

The Chairman of the Committee is a senior officer of the Department appointed by the Minister.

National Advisory Committee on Mining and Metallurgical Research

"Mining" is defined to include all areas of underground and open pit mining of all solid materials.

"Metallurgical" is defined to include all areas of mineral processing and extraction metallurgy.

The Committee advises the Minister on:

(a) mining and metallurgical research in Canada;

(b) the coordination of federal research programs with others; and

(c) the sponsorship of university and other research programs and projects.

The membership consists of:

(a) a Chairman who is a senior officer of the Department, appointed as such by the Minister on the recommendation of the Deputy Minister;

(b) up to six representatives of the Canadian mining and metallurgival industries;

(c) up to three representatives of provincial governments or research agencies;

(d) up to three representatives of Canadian universities;

(e) up to three representatives of other departments or agencies of the Government of Canada; and

(f) individual scientists and engineers the Minister may designate because of special circumstances.

APPENDIX 2

FUNCTIONS AND PROGRAMS OF SECTORS AND BRANCHES

I. MINES AND GEOSCIENCES SECTOR

1. Geological Survey Branch

(a) The function of the Geological Survey is to investigate, describe and explain the geology of Canada, to provide a systematic knowledge of the geological history of the country, and to collect, analyze and interpret data that will assist industries and other federal and provincial government departments and agencies concerned with Canadian renewable and non-renewable resources, with land use, or with engineering projects where ground stability is a concern, to formulate plans that will yield maximum economic and social benefits to the Canadian people. The Geological Survey initiates and conducts research and develops methods and equipment that have particular relevance to its functions and to Canadian geological and geographical conditions, and encourages the application of the results of its investigations and research, and of the results of relevant research done elsewhere, through technical publications and activities in technical societies, through co-operative industry-government organizations, through co-operation with other research and development institutions, with other federal and provincial government departments, with universities and institutes of technology, and by contact with individuals working in related fields.

(b) Principal programs

i Development of geochemical and geological techniques and criteria that will help industry find economic deposits of mineral. Fifty projects.

ii Geophysical surveys to supplement geological investigations and to outline areas favourable for the occurrence of mineral deposits. Ten projects.

iii Development of ground and airborne devices and techniques that will: (1) help industry find economic deposits of minerals, fuels and water; and (2) provide additional ways of supplementing geological investigations. Forty projects.

iv Investigation of the rock architecture of the Shield, Appalachian and Cordilleran regions and bordering continental margins, i.e., the rocks which have undergone mountain building and contain most metallic deposits. One-hundred and seventy projects.

v Investigation of the rock architecture of the western Plains and Arctic regions lying between the Shield and Cordillera, or north of the Shield. These rocks have been little altered by mountain building, and are the main known hosts of oil and gas. Ninety projects.

vi Investigation of the common unconsolidated deposits on the surface of the earth (sand, gravel, clay, etc.). Eighty projects.

vii Economic geology and metallogenic studies relating to the occurrence of various types of mineral deposits in Canada. Seventeen projects.

2. Mines Branch

(a) The function of the Mines Branch is to develop through research and investigation, mining and metallurgical technology that will lead to the utilisation and conservation of the Canadian resources of minerals, metals, energy and manpower in ways that will yield maximum economic and social benefits

to the Canadian people. The Mines Branch initiates and conducts research and development programs in mining and metallurgy that have particular relevance to Canadian resources and needs, and to Canadian economic and social conditions. The Mines Branch encourages the application by Canadian industry of the results of such research, and the application of the results of relevant research done elsewhere, through technical publications and activities in technical societies, through co-operative industry-government organizations, through co-operation with other research and development institutions, with other federal and provincial government departments, with universities and institutes of technology, and by contact with individuals working in resource-based industries.

(b) Principal programs

i Development of methods for improving effectiveness of explosives in mining. Six projects.

ii Development of a systems approach to mining. Two projects.

iii Investigation of ground control and stability problems. Seventeen projects.

iv Study of dust control techniques. Four projects.

v Development of methods for the concentration of low-grade ores. Thirty-two projects.

vi Investigation of problems of particular importance in the treatment of industrial minerals, with special reference to Canadian conditions. Twenty-one projects.

vii Development of new alloys utilizing Canadian-produced metals. Thirty-one projects.

viii Basic study of causes underlying the reasons why metals fail in service, due to fatigue, corrosion, etc.

Twenty-five projects.

ix Basic study of properties of sulphide minerals, that are the principal source of Canadian metals. Sixteen projects.

x Development of new methods for determining the composition, structure, and other properties of ore minerals. Twenty-one projects.

xi Development of methods for improving combustion efficiency of fuels, and minimizing pollution. Seven projects.

xii Basic study of beneficiation of Canadian fuels, and development of improved methods for their utilization. Eleven projects.

xiii Basic study of methods to improve coking techniques. Forty projects.

xiv Basic study of extraction metallurgy techniques, and development of new applications to Canadian mineral and energy sources. Twenty-eight projects.

xv Development of improved methods for minimizing corrosion of metals. Thirteen projects.

3. Surveys and Mapping

(a) The function of the Surveys and Mapping Branch is to provide the basic survey framework of fixed points for horizontal and vertical control and to carry out the basic mapping of Canada; to conduct investigations in geodesy, and to participate in international programs to study the true size and shape of the earth. The Branch utilizes its survey framework as control for the basic planimetric and topographic mapping of Canada, compiles and publishes the National Topographic Series of maps, organizes the air photo coverage of the country, produces the

national atlas and co-operates with other branches and departments to produce and publish specialized maps and charts to convey geological, geophysical, geographical, agricultural and other data about Canada. The Branch executes legal surveys for other departments of the federal government, co-operates with the United States on the maintenance of the Canada-U.S. boundary, and advises provincial governments, industry and other organizations on problems related to surveying, photogrammetry and cartography. The information gained through the activities of the Surveys and Mapping Branch is made available through the publication of maps and charts, by technical reports, by direct contact with interested persons, and through the participation of the staff in national and international committees.

(b) Principal programs

i Provision of basic vertical and horizontal control for geodetic use, controlling all surveys made in Canada. (This program is not formally reduced to projects).

ii Preparation and printing of basic topographic mapping of Canada and revisions to keep this mapping up to date; the derivation of smaller scale maps. The present program envisages the production of 920 maps at 1/250,000 scale, 7000 maps at 1/50,000 scale, and 750 maps at 1/25,000 scale.

iii Management of legal surveys under Canada Land Surveys Act. Three hundred and forty projects.

iv Production and printing of aeronautical maps, air pilot publications, and similar publications. The production of the most recent electoral map involved 441 projects.

4. Observatories Branch

(a) The function of the Observatories Branch is to investigate, describe and explain the magnetic, gravity and seismic characteristics of the earth as a whole and of the Canadian land mass in particular, to provide a national time service, and to participate on behalf of the Federal Government in international projects involving stellar physics and radio astronomy. The Observatories Branch collects, organizes and analyses data, and initiates and conducts research and development programs that have particular relevance to its functions and to Canadian problems, and utilizes the results of its investigations and research, and of the results of research done elsewhere, to obtain new and more detailed knowledge of the Canadian land mass, leading to improved magnetic and gravity charts, improved knowledge of earthquake hazards and improved detection of underground nuclear explosions, and to obtain new and better knowledge of the universe, of which the earth is a part. The information gained through the activities of the Observatories Branch is made available through publications, by direct contact with interested persons, and through the participation of the staff in national and international committees.

(b) Principal programs

i Development of methods for the determination and dissemination of accurate time.

ii Investigation of properties and composition of meteorites, history of their effects on the earth, and relationship with stellar bodies. Four projects.

iii Studies on the properties and characteristics of the earth's crust and deep interior; includes

monitoring earthquakes and detection of nuclear explosions. Six projects.

iv Study of the magnetic field in Canada, and its variations, both to aid navigation and to investigate the ancient history of the earth. Five projects.

v Study of variations in the gravitational field in Canada, relating this to the shape of the earth, and to problems in accurate surveying.

vi Astrophysical research, utilizing radio astronomy. Three projects.

vii Astrophysical research, utilizing telescopic techniques. Two projects.

5. Polar Continental Shelf Project

(a) The function of the Polar Continental Shelf Project is to increase the scientific and technical knowledge about the arctic regions of Canada, by providing means for integrating or co-ordinating Arctic investigations, by developing the specialized knowledge and experience in technology, logistics, communication and human problems to make possible effective scientific and technical work in the Arctic regions, and by making such facilities and knowledge available to responsible organizations. The project works directly with other Branches of the Department to plan and carry out an integrated program of Arctic research and survey, and conducts independent investigations to obtain information of basic importance about Arctic phenomena, resources or conditions. It also co-operates with other Departments and government agencies, and with universities, to provide expertise and facilities for arctic studies. The information gained through the activities of the

Polar Continental Shelf Project is made available through publications, through participation by the staff of the Project in the planning and organizing of many programs or studies connected with the Arctic in which the Government of Canada has an interest, and through direct contact with interested persons. This information is used in the development and assessment of policies for application in arctic areas by governments, by industries, and by academic and other organizations.

(b) Principal programs. (Most programs are undertaken in co-operation with other departmental branches, or other agencies).

- i Aeromagnetic surveys of arctic regions, and preparation of aeromagnetic maps. Five projects.
- ii Geodetic and topographic surveys of arctic regions to improve surveying techniques, and knowledge of glaciology. Five projects.
- iii Investigation of marine geology of the arctic continental shelf and continental slope. Two projects.
- iv Investigation of terrestrial geology of arctic regions. Two projects.
- v Geomagnetic study of an anomaly on Ellesmere Island.
- vi Glaciological study of the Meighen Ice Cap.
- vii Gravity investigations near the North Pole.
- viii Measurement of heat flow through the arctic ocean floor.
- ix Hydrographic survey of the arctic continental shelf and slope.
- x Oceanographic survey of arctic waters near the continent.

xi Investigation of the formation, movement and break-up of arctic sea ice.

xii Seismic investigation of the continental shelf and continental slope.

II. MINERAL DEVELOPMENT SECTOR

1. Mineral Resources Branch

(a) The function of the Mineral Resources Branch is to collect, organize and analyze data about the non-renewable resources of Canada, about Canadian industries directly based on such resources, and also about the non-renewable resources and related industries of the world where such data have implications for Canada. The Branch relates these data in the light of new developments in the technology of minerals and mineral products, of expected rates of expansion of the Canadian economy, of the amount and type of related infrastructure, of the growth and changing distribution and character of the Canadian labour force, of the source magnitude and availability of capital, and of the locations and types of Canadian mineral resources, to forecast likely patterns of world-wide mineral developments, and the effects these developments may have on Canadian activities both regionally and nationally. The data, and the conclusions drawn from them, are made known to the government through confidential reports and to the public through departmental publications, and can serve as a basis for policy decisions by federal and provincial government departments and agencies, and by industries that are concerned with Canadian non-renewable resources.

(b) Principal programs

i Surveys of Canadian mineral commodities, from the

economic and engineering point of view. Six projects.

ii Surveys of mineral distribution in Canada, and its potential effect on regional economic health. Three projects.

iii Economic assessment of major mineral projects. Two projects.

iv Economic evaluation of some major Federal programs relating to minerals. Two projects.

v Study of the economic implication of the Royal Commission on Taxation recommendations (Carter Commission). Five projects.

vi Preparation of the annual Canadian Minerals Yearbook. Sixty projects.

III. WATER SECTOR

1. Marine Sciences Branch

(a) The function of the Marine Sciences Branch is to carry out hydrographic and oceanographic surveys and studies to meet the national requirements for nautical charts and associated publications on Canada's coastal and inland waters, and for oceanographic information, atlases, and publications; to carry out surveys of marine resources on the continental shelf and in adjacent oceans; to carry out and publish oceanographic studies of water properties, marine pollution, currents, waves and related phenomena in the interest of fisheries, transportation, coastal engineering, and defence; to undertake research in wave theory, diffusion, large scale circulation patterns, time and space variability, and related marine phenomena whose understanding is essential for effective use of oceanic resources and the marine environment; to advise on the formulation of Canada's position and policies in international relations, negotiations, and jurisdictions concerned with the oceans. The information gained through the activities of the Marine Sciences Branch is made available through publications, including maps, charts, tables and scientific papers, through direct contact with interested persons, and through the participation of the staff in national and international committees and bodies.

(b) Principal programs

i Hydrographic surveys; publication of nautical charts and sailing directions of Canada's coasts, continental shelves and inland waters. Fifty-one projects.

ii Marine geophysics; studies of the structure of the continental shelf and slope and the mid-Atlantic ridge. Four projects.

iii Marine geology; geological investigations of sedimentology, geomorphology and bedrock geology and interrelations between the sea-bottom and overlying matters. Thirteen projects.

iv Investigation of ocean water circulation. Thirteen projects.

v Coastal oceanography (Gulf of St. Lawrence). One project.

vi Applied oceanography; surveys and studies to meet practical needs of fisheries, defense, coastal engineering, navigation and pollution. Six projects.

vii Air-sea interaction; measurement of the interchange of energy between the atmosphere and the sea. Two projects.

viii Chemistry and marine radioactivity; use of chemical analysis to identify various water masses and use of fission products from atmospheric fallout for the study of transport phenomenon in the oceans. Two projects.

ix Frozen sea research; studies of the processes involved in the growth and decay of ice cover over the sea. Four projects.

x Physical oceanography of the arctic. Two projects.

xi Ocean station "P"; oceanographic measurements from the D.O.T. weatherships in the North Pacific Ocean. One project.

xii Tides and water levels; analysis of tide and water levels on the coasts and the Great Lakes, St. Lawrence Waterway. Three projects.

xiii Investigations into tidal research, storm surges, waves and theoretical geophysical fluid dynamics. Six projects.

xiv Canadian Oceanographic Data Centre. Four projects.

xv Computing services and data processing research. Three projects.

xvi Metrology; research, design and development of instruments in support of oceanographic research. Three projects.

xvii Engineering services; maintenance of a wide range of oceanographic and hydrographic equipment and instruments. One project.

2. Inland Waters Branch

(a) The functions of the Inland Waters Branch are to investigate and describe the inland water resources of Canada, and to determine from the viewpoint of science and engineering how these resources may best be utilized for the benefit of the people and the industries of the country, at the same time recommending measures so that the resource may be renewed in perpetuity. The Inland Waters Branch collects, organizes and analyzes data on inland waters, conducts investigations and research on the sources and effects of polluting agents on water quality and on methods of controlling pollution. The Branch encourages the application of the results of its investigations toward the best utilization and conservation of inland waters through liaison with other federal departments and agencies, provincial agencies, universities, consultants and industry, through technical publications and activities in technical organizations, and by contributing its data and expertise toward the formulation of an effective national water policy

(b) Principal programs

i Maintenance of an inventory of Canada's water resources, through measurements of river flows, lake levels, etc. Nine projects.

ii Investigation of factors controlling lake water circulation, and sediment transportation in rivers. Fifty-eight projects.

iii Investigation of the causes of pollution of inland waters, the effects of pollution, and methods of abatement. Twenty-eight projects.

iv Development of methods, including engineering systems, for the most effective utilization of Canadian inland resources. Twenty-five projects.

v Investigations of factors governing the behaviour and occurrence of groundwater, ground ice, glaciers, and surface water. Forty-eight projects.

vi Basic scientific research on the physical and chemical properties of water, and the effect of natural substances, pollutants and biological materials on its characteristics. Six projects.

3. Policy and Planning Branch

(a) The function of the Policy and Planning Branch is to collect information on water and related resources to determine the effects of industrial developments, population growth and changing population distribution on renewable resource development and use, and their consequences for the economic, social and well-being of Canadians. The Branch coordinates, advises on, and conducts studies of regional water systems and river basins, and conducts research into their economic impact on neighboring communities. The results of the investigations undertaken by the Branch are made available to the public through reports, symposia and technical journals, and can serve as a basis for policy decisions by federal and provincial government departments and agencies, and by industries that are concerned with renewable resources.

(b) Principal programs

i Investigation of water resource systems to develop techniques for mapping watersheds and river basins, and planning their utilization. Seven projects.

ii Development of techniques for land-use planning. Seven projects.

iii Investigation of economic aspects of the management of regional resources. Seven projects.

iv Study of the problems involved in the co-ordination of resource policies.

v Investigation of the effects of water pollution.

vi Investigation of problems in common property resource management.

vii Post-mortem analysis of a major resource decision.

viii Preparation of information and reference systems on water resources.

IV. ENERGY DEVELOPMENT SECTOR

(a) The function of the Energy Development Sector is to provide advice to the Federal Government about the development of the energy resources of the nation, including hydroelectric sources, oil and gas, uranium and coal. The Sector cooperates with the National Energy Board, with Atomic Energy of Canada Ltd., with provincial governments and with industry, and maintains liaison with parallel agencies in the United States and other countries, to encourage the development of economically viable enterprises designed to meet Canadian energy needs, immediate and future. The Sector is responsible for the administration and management of Federal interests both in off-shore energy resources and in federally-owned mineral rights in the provinces and territories.

(b) Principal programs

- i Study of present and potential hydroelectric power developments, and their economic effects. Four projects.
- ii Study of present and potential uses for solid fuels, including uranium, with particular reference to overall policies and regional aspects.
- iii Study of research needs in the field of high voltage direct current equipment.
- iv Analysis of oil and gas resource development trends in relation to national policies and regional implications.
- v Investigation of the economics of oil refinery and marketing proposals.
- vi The monitoring of offshore mineral jurisdiction problems.
- vii Study of the potential peaceful uses for the seabed.

EXAMPLES OF RESEARCH PROJECTS

The programs outlined above are designed in the main to obtain basic information necessary for the economic and social well-being of Canadians. The programs impinge on Canadian economic and social life both indirectly and directly. The impingement is indirect when the Department has been engaged in laying a foundation of information on which it and other organizations may later build, direct when the Department has seen a specific need for an instrument or a technique and has developed the instrument or technique. On this basis projects may be described as basic research, applied research, and development.

Some examples of projects that can be described as basic research, applied research, or development, are listed below. Some projects that started as basic research have since developed to have clearly defined applications. This is an indication that the original basic research was well chosen to forward the mission of the Department.

I Basic Research Projects

1) Analysis and Prediction of Tides

In 1960 it was decided that a small unit should be established in the Department to provide a Canadian competence in theoretical tide research. At that time almost all Canadian work in this field was contracted out to the Liverpool Tidal Institute in England and it was clear that several fields in oceanography would suffer if a Canadian body of knowledge did not exist. Very quickly advances were made in the theory of harmonic analysis, especially in the application of high speed digital computers. This enabled many problem areas to be tackled which were beyond the scope of existing techniques. The results of this research, "The Analysis of Tides", by Dr. Gabriel Godin of this Department will shortly be published jointly by the University of Toronto and the University of Liverpool Presses.

At about the same time the possibility of using electronic computers for preparing tidal predictions was being explored in the Department, and this provided a basis for the rapid solution of the problems involved. Canada was the first country to publish its tide tables based on electronically produced predictions, and this country has played a major role in the international standardization of computer formats to permit the ready exchange of tidal information between nations.

The way was also opened to use powerful computer techniques to extract far more data from the sixty-year accumulation of tide and water gauge records. For the first time, data on storm surges could be readily extracted and subjected to separate analysis. The new techniques have also been of great value in special studies of the possible effects of the proposed Bay of Fundy power project.

2) A New Tectonic Map of Canada

In 1958 the Department was asked to prepare a tectonic map of Canada as a contribution to a tectonic map of the world to be published by the International Geological Congress. As a result a tectonic map committee was set up under the chairmanship of a senior Geological Survey officer with members from the Geological Survey of Canada, the Geological Association of Canada, the Alberta Society of Petroleum Geologists, and from various provincial governments. With the co-operation and contributions from these sources a tectonic map was prepared at a scale of 1:5,000,000, the colour proof of which was displayed at the 1968 International Geological Congress at Prague. The manuscript will be printed as Geological Survey map 1215A.

The map portrays the geological structure in a way quite different from a conventional geological map and in a manner not previously done for Canada. The geology is shown in terms of periods of deformation and alteration, and the rocks are categorized according to their structural environment. The research needed to produce the map resulted in much new information

concerning the time classification of Precambrian rocks and the structural provinces and sub-provinces in the Canadian Shield. This unique map contains much new information of value for those concerned with mineral exploration.

3) Array Seismology

In April 1962, the Defence Research Board approached the Department about the possibility of locating a large seismic array in Canada to further research into the detection and identification of underground nuclear explosions. As a result, the Department established a seismic array at Yellowknife, N.W.T., which is now operated by the Department.

The full array became operational at Yellowknife in late 1963. A Canadian research group was developed, which planned from the start to approach the massive array data processing problem by computer means. Early in 1966, computing time on an adequate high speed computer became available, and the Canadian-designed methods were demonstrated to be workable. By March 1967, an in-house special purpose data conditioning centre was in full operation based on laboratory interfacing to a small but powerful digital computer. By October 1967 a staff of four research scientists, expert in this field, was at work utilizing this modern facility and exploiting the breakthrough in technology afforded by the Canadian trials.

As a result of this work, a number of papers have been published on the automatic screening of earthquake data, on discriminants between explosions and earthquakes, and on the positive identification of explosions. In addition, advances have been made both on our knowledge of the top few hundred km of the earth, and also on deep mantle discontinuities. The group is now accepted as one of the world's expert groups in the detection-identification field, and the group is able to provide technical advice and information to other government departments, as for example the Department of External Affairs.

Catalysts for Petroleum Refining

In the refining of petroleum, and in the petrochemical industry in general, most processes depend upon a suitable catalyst to bring about the desired reaction. The composition and structure of catalysts are usually closely guarded secrets that are only divulged to the purchaser of a complete process technology.

The Department has been concerned with the development of catalysts that would be effective in the removal of sulphur, nitrogen and oxygen from residual oils. Residual oils are much used for heat generation, but their sulphur and nitrogren contents in particular are major contributors to atmospheric pollution. It was recognized also that catalysts that were suitable for treating residual oils would have application in the refining of oils obtained from the Athabasca Tar Sands.

By studying the basic chemistry of catalyst structure new techniques have been developed for making catalysts with large pore openings to accommodate the large molecules found in residual oils and tar sand products, while improving the ratio of surface area to wiehgt of the catalyst, which is related to is effectiveness.

This work has recently led to the granting of one patent, and applications for two patents are in process.

5) Chemical and Physical Factors Controlling Some Metallurgical Reactions

Almost all the chemical reactions that occur during the processing of minerals to produce metals and metallurgical products involve interactions between two phases, that is reactions between solids and gases, solids and liquids, liquids and gases, or solids and solids. The efficient utilization of these reactions in metallurgical processing requires both a precise knowledge of the conditions under which they will proceed, and a precise knowledge of the factors that control their rates, since it is the rate of a reaction that determines the productivity that can be obtained from it. However, the study of reactions of the types described presents

considerable problems in developing experimental techniques.

A broadly based program in the Department to study metallurgical reactions involving two or more phases has led to the development of improved techniques for conducting investigations of this type, and new insights into the mechanisms of some commercially important processes. Two improvements in Canadian metallurgical operations have resulted from the application of ideas developed during the program, and a project of applied research on a novel process for recovering sulphur from sulphide ores has been launched. In addition the forty-five papers that have been published describing the techniques and results obtained have attracted international attention.

II Applied Research Projects

1) The Cape Breton Coal Problem -

Officers of the Department comprised the research and operational staff of the Donald Enquiry into the Cape Breton coal problem. The problem was investigated on three major fronts:

(1) An examination of past trends and the current status of the following key factors; capital expenditure in the mines, operating costs, productivity, wage trends, markets, tonnage produced, and the cost of subsidies.

(2) A costing of alternative future policies by simulating such policies over a fifteen year period. The key inputs into the simulation models were: number of mines operating, annual tonnage produced, operating costs, labour force, sales price and tonnage purchased by each major customer or customer grouping. The key output was the subsidy cost required to realize a particular policy.

(3) A study of the social implications of alternative future policies by a simulation of the characteristics of the coal mine labour force under the different policies, over a fifteen year period. They key inputs were:

(i) The present structure of the labour force broken down by marital status, and the number in each age group, by year.

(ii) The past and expected future trends in voluntary resignations.

(iii) The labour force required under alternative future policies.

(iv) Application of mortality rates (using the 1961 Canadian census mortality rates for males).

The key outputs were a projected labour force balance over a fifteen year period showing either an excess of labour available over that required or a shortage and hence a need for new entrants.

The policy choices presented by the results of costing the various alternatives fell into two broad and widely different categories. Either (a) the existing situation would be maintained at great cost, and at the end of fifteen years there would be little to show for the capital expenditure, but instead, the likelihood of only a greater crisis developing than at present, or (b) the realities of the situation would be faced up to, the fact that this coal resource base is totally uneconomic at the present time and in the foreseeable future would be recognized, and a program of coal mine closures implemented. The analysis led to the recommendations contained in the Donald Report which recommendations were accepted by the Government. The culmination was the creation of the Cape Breton Development Corporation and the adoption of a program for Cape Breton Island which marks the commencement of a new and interesting approach to the problems of a declining mining community.

2) A New Gravity Map of Canada

Gravity data over the earth's surface are necessary for cooperative international attempts to determine the accurate shape of the earth, and are essential for determining precise missile trajectories and azimuths. The need of gravity data for these purposes has been highlighted recently by requests of the Department of National Defence for an accelerated gravity mapping program.

Gravity data have a more immediate application for mapping major structures of the earth's crust as an aid to the mineral and

petroleum industry and to the earth sciences generally. Approximately 200 requests for gravity data were received from industry during 1964, and these increased to about 300 during 1967. Largely as a result of the recent increase in activity in exploration, specific requests for data are expected to reach at least 500 during 1968.

The recent publication of a new gravity map of Canada, representing the results of all gravity measurements completed in Canada to the end of 1966, represents the Departmental response to these requirements. Data for some 95,000 stations systematically distributed at intervals of about 8 miles provide basic gravity information for approximately 70 per cent of the land surface of Canada, including the continental shelves of the Atlantic, Pacific and Arctic Ocean basins. The new Gravity Map reflects the cumulative result of researches in the Department to develop new and better techniques of measuring researches, which have received international recognition, are:

(i) Development of survey techniques to economically provide systematic coverage of the remote and unsettled areas of Canada using aircraft transportation. This involved development, maintenance and calibration of instruments and standards, as well as the development of field procedures.

(ii) Development of an automated system to reduce, store and retrieve geophysical data consistent with requirements of the exploration industry and earth scientists generally.

(iii) Development of new methods to analyse and interpret geophysical data.

3) <u>Stability of Slopes in Open Pit Mining</u>

The Canadian mining industry spends between fifty and one hundred million dollars per year excavating waste during open pit mining operations. The amount of waste to be removed is closely

related to the steepness of the slopes of the sides of the open pit that can be established with safety. Until recently this has been entirely a matter of individual judgment based on experience.

An explicit method has been established for determining quantitatively the probabilities of failure for various slope angles for various rock types, which can be combined with an economic analysis that includes the cost of additional waste extraction to achieve any specified probability of failure. This information enables the open pit operator to determine quantitatively the optimum angle for the sides of an open pit.

The financial returns from the operations on which this procedure was developed have already more than paid for the cost of the research. Much wider application of the technique may be expected.

4) Operation Keno

In 1963 the near-future outlook for mining in the Yukon, the Territory's principal industry, was discouraging. This was principally due to the fact that United Keno Hill Mines, the Territory's only producing mine, appeared to have a limited life. As a result, the Department arranged to mount Operation Keno in 1964. This was a helicopter-supported geochemical investigation of some two thousand square miles adjacent to the United Keno Hill property, that was believed to include the same lead-zinc-silver belt. The purpose of the Operation was twofold: (1) to provide geochemical data that would aid in the search for new nearby deposits of lead, zinc, silver, gold, tin and tungsten; and (2) develop, test and emonstrate geochemical methods and techniques applicable to prospecting there and elsewhere in Yukon.

Fourteen maps incorporating the results of this work were issued in 1965 and others have been released since. These maps indicate the heavy metals, lead, zinc, copper, silver, etc. that were present in stream sediments and waters. Many anomalies were indicated that led to extensive staking early in 1965. As a result

of this work at least two new lead-zinc-silver belts have been discovered, and these have been found to contain promising prospects still under investigation. In addition, partly as a result of this demonstration, geochemical methods are being widely used in the current active prospecting going on in many parts of the Yukon.

5) Comprehensive Survey of Hudson Bay

In 1961 a reconnaissance survey of Hudson Bay was carried out by M. V. Theta, on charter to the Department and M. V. Calunus, a Fisheries Research Board ship. This included both biological and physical oceanography and a number of relatively new exploration techniques to study the sediments and structure of the Bay. One of the reports resulting from this work inferred that there is a relatively deep sedimentary structure beneath central Hudson Bay.

As a result of this preliminary work several oil companies took out oil and gas exploration permits. The potential economic importance of the area led to a much larger survey in 1965 carried out by CSS Hudson, two chartered ships and a chartered aircraft. This co-operative venture included four separate scientific groups from the department, research teams from several universities and one oil company. An electronic position fixing system was installed to enable the results of the geophysical, geological, oceanographic, biological and hydrographic work to be accurately correlated. The universities concentrated on crustal studies of the Bay which are of great scientific interest. There was a full interchange of data between all the scientists concerned who are still analysing the details of the deep sedimentary structure which are of considerable commercial interest.

The importance of the role of the northern oceans as a major influence on world climate is well known and various major engineering projects have been suggested from time to time with the intention of changing the climate of the Arctic. However, recently it has been suggested that the ice cover may be both a critical and an unstable factor in the interaction between the ocean and atmosphere.

Research incorporating the oceanographic work in Hudson Bay will be of great significance in evaluating whether or not the overall influence of ice cover at high latitudes is beneficial.

III Development Projects

1) Control of Slag Formation in Steam Boiler Tubes

The widespread use of residual oil for the firing of steam boilers has resulted in major boiler maintenance problems as a result of slag formation in boiler tubes. Basic research in Departmental laboratories led to the development of a theory of the mechanism of slag formation which has led to the discovery of a fuel oil additive that completely prevents slag formation.

The extension of the ideas underlying this investigation led to the discovery of other additives that greatly reduce the pollution of the atmosphere that results from the burning of untreated oil, both with respect to the solids discharged and to the acid-forming gases such as oxides of sulphur.

As a result of these developments, one patent has been issued, and a second patent is pending. A new company was formed in the United States to manufacture and market the additives, and following its commercial success two established Canadian companies are starting manufacture in Canada.

2) High-resolution Magnetometer

Aeromagnetic maps, which are obtained by flying an airborne magnetometer over the country, are of invaluable assistance to the geologist and the prospector. However, the sensitivity of the current instruments is such that large areas of the Canadian Shield, and all of the gently inclined sedimentary strata that border it, appear magnetically featureless. Thus, much more sensitive magnetometers are needed to obtain geological information from these places. Because of this need, the Department, in cooperation with the National Research Council embarked on a program to develop a high resolution airborne survey system which would be commercially attractive. As a result, a prototype rubidium vapour optical

absorption magnetometer was developed and test-flown in a North Star aircraft operated by the National Aeronautical Establishment to prove its usefulness. The instrument and ancillary equipment, including that needed for automatic compilation, has been miniaturized and is now being installed in an aircraft on lease to the Department. This system will be operated by the Geological Survey to demonstrate the technical capabilities of the system as a means of providing geological information not previously available.

3) Gamma-ray Spectrometer

Field instruments used in the search for uranium during the 1950's were incapable of distinguishing between valuable uranium and valueless potassium and thorium. Laboratory types of gamma-ray spectrometers were, however, becoming available that were capable of distinguishing and measuring the radioactivity from each of several radioactive elements. Such instruments were potentially adaptable for field use both as a means of detecting and measuring uranium in rocks, and as a means of classifying rocks by measuring directly the amounts of contained potassium, uranium, and thorium. Consequently work was started in the Department on the design and construction of a portable gamma-ray spectrometer for field use. The outcome was a prototype instrument that was tested in the Elliot Lake area of Ontario during the summers of 1965 and 1966. The design with minor modifications has been put into production by a Canadian instrument manufacturer and is now selling in several countries.

4) Instant Oxygen Analyzer for Molten Metals

Knowledge of the oxygen content in molten metals during various stages of processing is of fundamental importance to the metallurgical industry, because selective oxidation and subsequent deoxidation form the basis of many commercially important extraction metallurgy techniques. For example in the manufacture of steels, rapid and accurate determinations of the oxygen content of the molten metal make possible the production of cleaner and

higher quality steel, and at the same time reduce the amounts of expensive alloying agents that are required.

Research done in the Department has led to the development of an immersion-type disposable oxygen probe that provides an immediate readout of the molten metal's oxygen content on a meter. Patents for this device have been applied for in a number of countries throughout the world, and a Canadian company is planning production of these probes as a result of their acquisition of a licence to manufacture the equipment.

5) New Techniques for Conducting Hydrographic Surveys

The Department has been actively engaged for the past three years in developing new methods to expedite the surveys needed to produce hydrographic charts. In the past, surveys have largely been carried out using slow launches of traditional design and soundings have been fixed by sextant angles to accurately positioned objects on the shore. Unless extremely complex, heavy and expensive electronic equipment was used, surveys could only be carried out in sight of land, and mist or haze could drastically reduce productivity.

Field trials of the following components of a new system that will eliminate many problems have been successfully completed:

- HYPOS, a semi-automated system for the rapid processing of survey records from the sounding rolls and field notes to the completed field sheets.
- "SONODIST", a tone burst sound ranging system, developed for us by the National Research Council, facilitates station keeping when several launches are sounding in formation. This equipment will drastically reduce the personnel required on each launch.
- Minifix, a light weight electronic positioning system, developed to meet our requirements by Computing Devices of Canada Limited, includes two new features, a punch-paper output of position data to expedite processing and a 'left-right' indicator to enable the coxwain to maintain an accurate course.
- Hydrodist, a short range electronic system for use in harbour surveys where precise positioning is necessary.
- High speed Bertram sounding launches built in Canada, capable of sounding at speeds of twenty knots. These enable two or three times as much sounding to be accomplished in a day.

All of these components will be used as an integrated survey system for the first time in 1969 when a major resurvey of the Lower St. Lawrence River will be started. This is needed to ensure the safety of the deep-draft shipping which will be sailing Canada's most important water route in a few years' time. The new equipment will allow a far larger area to be surveyed each year and should reduce the time required to make new charts available for the use of mariners.

DEPARTMENTAL PUBLICATIONS

It is axiomatic that the work, either of scientific research or of data collection, is not complete until it has been published in some readily available form. The means whereby the Department ensures that its work comes to the attention of those who have need of it are discussed later in this brief. At this point it will be sufficient to record the Departmental publications for the fiscal year 1967-68, which was a respresentative year.

Number of papers published in scientific and technical journals	410
Number of reports issued as Departmental publications	430
Number of maps and charts published	1936
Number of volumes of data published	82

A discussion of the transfer of research results to those having need for them appears at the end of Section 4.

PATENTS ARISING FROM RESEARCH ACTIVITIES

The Department's research activities are directed toward the provision of services leading to the benefit of the Canadian public. The patenting of processes and equipment arising from those activities is incidental. However, if a process or item of equipment which seems to hold patent possibilities is developed, the invention is referred to Canadian Patents and Development Corporation for assessment. If its assessment indicates the advisability of patent action, the Corporation proceeds to take such action and to negotiate licence agreements for the use of the invention. The following table shows the status of departmental inventions handled by the Corporation during the fiscal year 1967-68.

Title	Status of Invention
Map Tracing Method and Apparatus	Can. Pat. No. 664,164
Recovering Vanadium Ore	U.S. App. No. 534,960 Can. App. No. 962,408
Electronic Ceramic Compositions	U.S. App. No. 538,006 Can. App. No. 927,069 U.K. App. No. 14606/66
Portable Rock Drill	Can. Pat. No. 747,770
Proton Precession Magnetometer	Patents in U.S.A., Canada, U.K., Australia, France, S.Africa, Sweden. Applications pending in Germany and Mexico. 5 Licences Granted
Method and Apparatus for Measuring Magnetic Intensity	Patents in U.S.A., Canada, U.K. France, S.Africa, Australia & Mexico. Pat. apps. in Germany & Sweden 2 Licences Granted
Deep Water Wave Recorder	U.S. App. No. 501,632 Can. Pat. No. 768,793 1 Licence Granted
Rock Drill Assembly	U.S. Pat. No. 3,213,951 Can. Pat. No. 738,863
Process for Smelting Iron Ore with a Cyclone Combustor	Can. Pat. No. 610,309
Process for Smelting Iron Ore with a Cyclone Combustor	U.S. Pat. No. 3,216,818
Compound Water Cyclone	Patents in Canada, U.S.A., U.K., Australia, France, S. Africa, and India. Apps. pending in Germany, Sweden, Holland, Japan and Mexico 1 Licence Granted

Title	Status of Invention
Method of Treating Coal	Can. Pat. No. 697,251
Digital Recorder	Can. Pat. App. No. 974,450
Flotation Process for Upgrading Cassiterite Concentrates	Can. Pat. No. 770,660 U.K. Pat. No. 1,079,619
Method and Apparatus for Producing Air-Fuel Flames of Sonic and Supersonic Velocities	Patents in Canada, U.S.A., Norway and S. Africa Apps. pending in Sweden and Brazil 1 Royalty free licence granted
Process for Utilizing Hydrocarbon Injection into Hot Reducing Gases in Steelmaking	U.S. Pat. No. 3,356,488 Can. Pat. No. 752,792
Treatment of Copper and Nickel and Their Alloys	Patents in Canada & U.S.A.
Method of Orienting Fibres by Means of AC and DC Voltage	U.S. App. No. 616,904 Can. App. No. 008,188
Prevention of Gas Absorption in Metals	Patents in Canada, U.S.A., France and U.K. Apps. pending in Germany, and Japan 1 Licence Granted
Treatment of High Antimony Bearing Gold Ores	U.S. Pat. No. 3,174,848 Can. Pat. No. 675,560
Method of Making Electromagnetic Measurements	U.S. Pat. No. 3,114,103 Can. Pat. No. 654,552
Ion Bombardment Camera for Crystal Orientation Determination	Patents in U.S.A., Canada, U.K., France and Japan Patent app. in W. Germany
Corrosion Inhibition in Fuel Fired Equipment	Can. App. No. 936,282 U.S. App. No. 566,257 1 Licence Granted
Type E Stoker Grate	Can. Pat. No. 609,355 U.S. Pat. No. 2,967,496 3 Licences Granted
Stoker for the Combustion of Coal	Can. Pat. No.621,375 U.S. Pat. No. 3,117,537 U.K. Pat. No. 976,811 1 Licence Granted
Process for Preparation of an Inorganic Gel Having a Predetermined Pore Structure	Can. Pat. No. 706,356 U.K. Pat. No. 1,015,792 App. pending in U.S.A.
Corrosion, Pitting and Tarnish Resistant Stainless Steel	Patents in Canada, U.S.A. and U.K. App. pending in Sweden
Stabilization of Chromium Nickel Stainless Steel	U.S. Pat. No. 3,203,789 Can. Pat. No. 690,750
Recovery of High Purity Magnesium Oxide from Magnesite and Calcite Ores	U.S. Pat. App. No. 481,922 Can. Pat. App. No. 962,408
Beneficiation of Carbonate Rocks and Minerals	U.S. App. No. 646,475 Can. App. No. 951,851

Title	Status of Invention
Demagnetizing and Magnetic Segregation Cone	In abeyance -- waiting for results of tests
Method of Removing Aluminum Oxide from Aluminum-Killed Steels and Steels Produced by such Method	Patents in U.S.A., Canada, U.K., France, Germany, Italy and Sweden Application pending in Japan
Free Machining Steels of Improved Transverse Mechanical Properties and Method Making Same	Patents in U.S.A., Canada, and U.K. Application pending in Japan.
A Method and Apparatus for Inductive Prospecting	U.S. Pat. No. 2,919,397 Can. Pat. No. 680,595
Propane Gas Heater for Water Wells	Can. Pat. No. 633,674
Smoke Reducing Method and Apparatus for Stokers	U.S. Pat. No. 3,044,422 Can. Pat. No. 663,319
Cyclone Fired Cupola	Can. Pat. No. 618,814
Reduction in Coke-Combustion in Slag-Iron Process	Can. App. No. 937,914 U.S. App. No. 559,865 filed 23.6.66
New Apparatus and Method for Automatic Ground Faults Clearing	U.S. Pat. No. 3,341,741 Can. Pat. No. 777,407
Hypereutectic Aluminum-Silicon Alloys Containing Refined Silicon	U.S. App. No. 588,343
Method of Calibrating and Electro-magnetic Seismograph	Patents in U.S.A., and Canada 1 Licence Granted
Uranium Bearing Steels	Patents in Canada and Chile
Method of Improving the Usefulness of Electric Arc Furnaces	Can. Pat. No. 776,106 U.S. App. No. 616,984
Recording Magnetometer	Can. Pat. No. 611,194 1 Licence Granted
Filler Material for Welding	Can. Pat. No. 746,847
Apparatus for Atomizing Liquids	Can. Pat. No. 597,146 1 Licence Granted
Method of Thermally Working or Piercing a Body of Rock	Can. Pat. No. 722,510
Production of Low Silica Iron Superconcentrates	U.S. Pat. No. 3,273,707 Can. Pat. No. 739,531
Slugging Cyclone	U.S. Pat. No. 3,366,247 Apps. filed in Canada, U.K., Sweden, Germany, France, India, Australia, Japan, S. Africa, Holland, and Mexico 1 Licence Granted
Combined Steam Exhaust-Heated Gas Turbine Plant	Can. Pat. No. 626,261

Title	Status of Invention
Method and Apparatus for Sorting Ores	U.S. App. No. 526,103 Can. App. No. 923,090
Fuel Oil Additive for Slag Prevention	Can. App. No. 648,241
Nuclear Magnetic Resonance Magnetometer	Can. Pat. No. 706,520
Compacting and Forming Semi-Conductor Materials without External Heat	Can. App. No. 970,307 U.S. App. No. 664,946
Hollow Stoker Grate	U. S. Pat. No. 3,014,439 Can. Pat. No. 649,891 3 Licences Granted
Combined Steam-Gas Turbine Plant	U.S. Pat. No. 3,086,362 Can. Pat. No. 597,579
Topographical Stereoscopic Apparatus	Can. Pat. No. 740,181
Method of Drawing Cross Sections from a Contoured Map and Instrument Therefor	Can. Pat. No. 585,235
Concentric Jet Control for Direct Current Arc	Can. Pat. No. 568,053
Thermal Deposition of Metallic Titanium	Can. Pat. No. 562,205
Method of Preparing Titanium Trichloride	Can. Pat. No. 553,234
Semi-Hollow Stoker Grate	Can. Pat. No. 646,110 3 Licences Granted
Dump Grate	Can. Pat. No. 668,392 U.S. Pat. No. 3,078,839 4 Licences Granted
Process for the Preparation of Metal Oxides Having an Enlarged Pore Volume	U.S. Pat. No. 3,352,635 Can. Pat. No. 748,798
Galvanizing Process and Apparatus	Can. Pat. No. 780,330
Method of Treating Kyanite Concentrates	Can. Pat. No. 570,237 U.S. Pat. No. 2,866,714
Ilmenite Leaching Process	Can. Pat. No. 591,274
Orthogonal Magnetic Anistropy Meter	U.S. App. No. 665,008
A Superpositioning Image Slicer	U.S. App. No. 659,098
Radiohm Method for Earth Resistivity Mapping	Can. App. No. 994,601
Hydrostatic-Powered Rock Core Drill Mini-Mohole	Can. App. No. 989,565
Airborne Measurement of Bedrock Electrical Conductivity	Can. App. No. 997,018
Continuous Recovery of Tungstic Trioxide (WO_3)	U.S. App. No. 685,821 Can. App. No. 999,263
Automatic Digital Range Expander	Pat. App. to be filed in U.S.A.

Title	Status of Invention
Copper Electroplating Baths	Can. App. No. 639,500
Cadmium Plating High Strength Steels Without Hydrogen Embrittlement	Can. App. No. 639,312
Dual Mix Tank	Pat. App. to be filed in U.S.A.
Dispersion-Strengthening by Adding Refractory Compounds to Molten Zr, Ti or Ni	In abeyance
Total Magnetic Anisotropy Meter	U.S. Pat. App. No. 665,006
Modified Pattern Materials Incorporating Binder for Precision Casting	Pat. App. to be filed in U.S.A.
Direct Oxygen Probe for Liquid Metals	U.S. App. No. 680,471 Can. App. No. 000,185 1 Licence granted
Stable Silver Cyanide Plating Baths	Pat. App. to be filed in Canada
Pyrite Treatment	Pat. App. to be filed in Canada
Centrifugal Dewatering of Fine Coal by Oil Displacement	Under assessment
Use of Spherical Agglomeration in the Production of Coke	Pat. App. to be filed in Canada
Pulp Divider for Cyclone Separator	Pat. App. to be filed in U.S.A.
Surface Preparation of Steels with Hydrochloric Acid Without Embrittlement	Under assessment
Preparation of Highly Porous Alumina by Two-Stage Drying	Under assessment
A Cone Rolling Fixture	Under assessment

Revenue from Departmental patents amounted to $9,153.81 during the fiscal year 1968.

OUTSTANDING RESEARCH TEAMS AND FACILITIES

Measures of accomplishment and of potential influence are found in the establishment of teams with unique or outstanding capabilities in their fields, and in the development or acquisition of special equipment, techniques, and skills.

The list of teams with outstanding skills would be long because all the branches and institutes within the Department occupy unique positions in their fields in Canada. The following will therefore be only a sampling of teams and facilities with unusual capabilities.

Geological Survey of Canada

A large portion of the work in geology tends to be done by individuals or by small groups who combine temporarily for specific projects. This is especially true where field surveys are a major component. Team research, on the other hand, develops where there are continuing projects, especially those involving a major component of laboratory work, such as mass-spectroscopy and isotope dating, including the development of instrumentation and continuing refinement of techniques in support of field research; biogeochemistry, involving geology, geochemistry and botany; clay mineralogy; and various geophysical projects, especially those involved in the development of remote sensing devices.

Examples of research tools and systems that have been developed include:

(1) High resolution aeromagnetic survey systems.

(2) Ground gamma-ray spectrometry.

(3) Development of airborne gamma-ray spectrometry for the search for radioactive minerals.

(4) Practical methods of field geochemistry for prospecting.

(5) Field methods for detection of Radon -222 in streams and sediments to outline uranium-bearing areas.

(6) 'Glaciofocus' a method of tracing mineral trains in glacial deposits back to source areas as an aid to prospecting.

In addition to some of these instrumentation and remote sensing developments the Geological Survey has led the world in rapid reconnaissance geological mapping using helicopters and other aircraft, especially in the field techniques developed and applied to the mapping of the arctic regions.

Mines Branch

The Mines Branch stands alone in Canada in the variety and scope of its research activities in mining, metallurgy, and fuels technology. There are teams of special competence -n most of its fields of endeavor, some of which have made major contributions to Canadian industry, as mentioned elsewhere in this report. In some cases, research teams of the Department have combined with representatives of private companies to undertake a joint enterprise. An outstanding example of this, which antedates the years specified in the guidelines but is worthy of mention nevertheless was the team on ore hydrometallurgy that contributed very substantially to the development of Canada's uranium industry in the 1950's.

A second such team which is active at present, is contributing to new mining technology by the study of rock mechanics. This team of scientists from the Department is working in collaboration with mining company engineers in the mine at Elliot Lake.

An example of work which has resulted in direct economic benefit was the development to the pilot plant stage of a process to produce metallurgical coke from Western Canadian coal. This made possible a long term contract to export coke to Japan.

A sample list of special facilities developed or operated by the Mines Branch follows:

(1) A fully automated diffractometer for X-ray diffraction data.

(2) A process for recovering uranium from ores by bacterial leaching.

(3) A combination shaft furnace and electric furnace for smelting pre-reduced iron pellets.

(4) An instant oxygen determinator for molten steel.

(5) High pressure chemical facilities at the Fuels Research Centre.

(6) A facility for investigating and certifying electrical equipment for use in explosive atmospheres.

(7) The Elliot Lake facility for the study and application of rock mechanics to Canadian mines.

(8) A 4-million pound testing machine for testing compression in rocks.

Surveys and Mapping Branch

Two research teams have been developed during the period 1962-67, one to improve the efficiency of topographic mapping by photogrammetry, and the other for research in geodesy and to improve the efficiency of methods used to conduct and analyze geodetic surveys. Both teams are unique in Canada since they work in close collaboration with groups actively engaged in mapping operations, as distinct from other researchers who are concerned with particular aspects, or basic problems in these fields.

Observatories Branch

The Dominion Observatory enjoys world-wide recognition as a centre of excellence in multi-disciplinary researches of meteors and of meteorite craters. The program in meteor astronomy is devoted to the study of the physics of meteors and in the recovery of meteorites. The investigation of meteorite craters on Earth is part of the study of interactions and encounters between members of the Solar System, particularly between the terrestrial planets and meteorites, asteroids and comets. The field of crater investigations includes the search for and identification of impact sites on Earth, and the determination of their structure, geophysical and geochemical properties, mineralogy and geologic history. It also involves experiments concerning the dynamic properties of geologic substances and analogous materials.

The knowledge so gained has application to the history of the Solar System, the nature, origin and abundance of meteorites and asteroids, the origin and history of surface features on the Moon, Mars and similar planetary bodies and to the history of the more stable parts of the Earth's crust. The analysis of field and laboratory observations,

coupled with pertinent experiments, has led to a better understanding of the dynamic properties of the Earth's crust and the nature of its response to high-energy shock pulses. These results have application to the field of rock mechanics and to the contemplated use of nuclear explosions for large excavations. The studies are also of significance to the mining and oil and gas industries as large impact structures have in some cases formed or controlled the distribution of deposits of economic importance.

Scientists at the Dominion Observatory realized that many other old impact craters might be preserved on the extremely stable Canadian Shield, and initiated the world's first systematic search for ancient meteorite craters using air photographs, maps and other information. The initial hope has been more than justified by the outcome. To date sixteen impact sites have been identified in Canada while an even greater number of possible sites are considered worthy of further investigation. The Canadian investigations have been distinguished by the broad approach taken to the problems of crater identification and analysis. Gravity, magnetic, seismic, resistivity, structural, topographic and petrographic methods have all been employed. Even more important has been the pioneering use of continuous diamond drilling to investigate the deep zones of a number of the craters. This program, begun in 1955, has received world wide acclaim as an unrivalled contribution to the field.

Telescope Design and Optical Teams

During the period 1964-68, while the Queen Elizabeth II telescope was an active project, two teams of outstanding competence were developed. The telescope design team has won world-wide renown for its innovations which were to have been incorporated in the new Observatory. This team worked in collaboration with a Canadian firm of consulting engineers who now have contracts for the design of the mounting system for an American telescope, and for the design of the entire tube of an Anglo-Australian telescope. They also are in a strong position for contracts for other telescopes currently being planned in other parts of the world.

A second team which was assembled for the Q.E. II telescope was the group of opticians who were to grind the mirror and other optical components. This team is regarded as second to none in the world.

The future of both these teams has been the subject of speculation since the cancellation of the telescope project. To date, however, neither has given indication of splitting up, and the Department hopes to be able to keep them intact, in the hope of both attracting international design work to Canada, and contributing further to astronomy in Canada.

Marine Sciences Branch

The Bedford Institute, constructed by this Department and shared with the Fisheries Research Board, is recognized as one of the finest oceanographic facilities in existence anywhere. Its excellent location on Bedford Basin at the inner end of Halifax Harbour, its outstanding waterfront and wharves, its first-class fleet and equipment, and its competent young staff combine to make it a show-place of marine research and surveys. CSS Hudson, commissioned in 1963, is one of the largest and best equipped research ships in the western world. She has an ice breaker configuration, a cruising range of 15,000 miles, and the capability to work anywhere in the oceans of the world. She is one of six major vessels (plus a larger number of minor craft and launches) operated by the Institute of marine surveys and research.

The staff at the Institute have developed special expertise in a number of fields, of which Marine Geophysics, including seaborne gravimetry and continuous automatic data processing, is outstanding. This group is unique in Canada and ranks with the finest in the world.

A second team has developed outstanding competence in the art of measuring currents by moored current meters - a much more difficult undertaking than the average layman usually imagines. A third team has developed a unique system for measuring some of the exchanges between the ocean and atmosphere which play a basic role in the processes of weather formation as well as the development of waves and ocean circulation. A fourth team has made important advances in describing and explaining the circulation of water in the Northwestern Atlantic Ocean

and the exchanges of water between the Atlantic and Arctic basins.

Inland Waters Branch

Team effort in the Inland Waters Branch takes many forms. For example, the Water Survey of Canada depends on a team of hydrometric experts to deal with streamflow measurements at 2,000 gauging stations throughout Canada. The Water Survey maintains technical and engineering support staffs to deal with special investigations on river-sediment transport and discharge measurements under ice. The Branch also organizes team efforts in the field of water pollution investigations. Scientists and engineers of the Water Quality Division, together with those in the Hydrologic Sciences Division and Great Lakes Division, apply many skills and disciplines to deal with major pollution problems in Canada. With regard to Great Lakes research, the Canada Centre for Inland Waters at Burlington, Ontario has an interdisciplinary program of scientific research and data collection on the Great Lakes. With a young and competent staff, the Canada Centre for Inland Waters is rapidly becoming one of the major scientific centres for limnological research in North America.

QUALIFIED PEOPLE WHO HAVE LEFT THE DEPARTMENT

One way in which the Department has influenced the fields of earth science and resource development is through the people who have attained prominence while members of the staff and who have then left to play significant roles in these fields elsewhere in Canada. While it would be impolitic to mention names, one can safely say, for example, that it would be hard to find a major exploration company (mineral or petroleum) or university geology department in Canada that does not have on its staff one or more former employees of the Geological Survey of Canada. The Mines Branch also, during the period 1962-67, has "contributed" at least three professors, and a slight extension in time would add another professor, and at least three presidents or senior executives of mining or metallurgical companies. Much of the core of the skilled staff in the photogrammetrical survey and mapping industry in Canada gained their initial experience in the Surveys and Mapping Branch. The Mineral Resources Branch has lost at least two economists to professional positions and one who is now doing valuable work as a consultant in the field of energy economics. This does not include a significant group of individuals who have held post-doctoral fellowships in the Department and who have since risen to positions of prominence.

There is some indication that the Department has been losing highly qualified staff members at an increasing rate during the last five years. For example the Geological Survey Branch has lost 26 staff members with Ph.D. degrees to universities and to industry since 1961, according to the following table:

Year	Number lost to Universities	Total Number Lost
1962	0	0
1963	1	1
1964	1	2
1965	2	4
1966	2	4
1967	3	6
1968 (to Sept. 18)	5	9

If this trend continues it could become a matter of serious concern. Salary does not seem to be a major consideration. Whatever the significance of the trend may be, it is clear that the conditions of employment outside government are at least as attractive to professional employees as those within government.

APPENDIX 3

Regional Distribution and Impact of Scientific Activities

Since the Department is broadly concerned with resources, virtually all of its work has effects on regional development. It is difficult, if not impossible, to be precise about either the amount of effort directed towards such development, or the results of these efforts. Every new mine that is opened owes some portion of its discovery to the work of the Geological Survey; every port that handles shipping owes something to the Hydrographic Service which charts the navigation lanes; every road builder owes something to the Topographic Survey; and so on and on. On the other hand, while most of the work of the Department is thus directed towards long-range results and the establishment of a basis upon which development can occur, there are instances where specific results emerge directly. The following are some recent examples:

1) Research on the extraction metallurgy of uranium led to the development of uranium mines and refineries at Elliot Lake, Ontario, Bancroft, Ontario, and Beaverlodge, Sask.

2) Research on the coking properties of western coals led to the development of major markets for the coal in Japan.

3) A pilot plant investigation of the treatment of a tungsten ore provided information of importance in the establishment of a mine and concentrator in the North West Territories.

4) A study of the labour supply in New Brunswick, and of the harbour possibilities along the north coast, provided information essential to the planning and construction of the Belledune lead-zinc smelter.

5) A long range economic study of the movement of iron ore through the St. Lawrence Seaway provided information essential to the consideration of toll and capacity levels in keeping with the

dual objectives of stimulating iron ore resources development. in the Labrador-New Quebec area and of recovering the costs of Seaway construction.

6) Economic Studies of the subsidized coal mining industry of New Brunswick led to the operation of the field by a provincial crown corporation with the object of rationalizing the uneconomic coal industry and of stimulating alternative economic activity.
7) A study of both economic and technical implications, in which the Department participated, has led to the Nelson River Development project which will produce several million kilowatts of hydro-electric power for both domestic and export markets.
8) Studies of the road-building programs into Northern Canada have assisted in giving priority to programs with most economic promise.
9) A safe, sheltered and scenic route was charted from Parry Sound to Killarney, eventually to be extended to Port Severn, as a basis for developing the tourist industry in Georgian Bay.
10) A study of tidal circulation in the Gulf of Georgia is providing information essential to the control of pollution of those waters, which would otherwise have an adverse effect on the salmon fishing.
11) Studies and negotiations directed towards rationalization of the Nova Scotia coal industry has led to the establishment of the Cape Breton Development Corporation (DEVCO) and hopefully will divert large sums of money from the support of uneconomic coal mining operations to viable projects, based in part on oil refining, petrochemical operations, and other enterprises particularly related to the regional economy.

Departmental activities also contribute directly to regional economies by the maintenance of local operations and establishments, an

arrangement which is practical for some activities, although not for others.

Much of the work in the earth sciences requires the description and analysis of physical features of the country, and therefore involves field investigations. In some studies, such as regional geology, most of the field work is done during the summer season, and the scientists return to a home laboratory to analyse and interpret their data during the winter period. In other cases, such as oceanography, conditions may permit or even require activity on a year round basis, and the field work continues without primary regard for season. Some units are concerned with specific features or regions of the country, and it is logical that they be located near the subject of their investigations; such, for example, is the Great Lakes Division which is located at the Canada Centre for Inland Waters at Burlington to study the limnology and associated problems of the Great Lakes, or the Institute of Sedimentary and Petroleum Geology which is located in Calgary to study the geology of the potential oil-producing areas of western and northern Canada. Other units may be employed as occasion demands anywhere in the country, and therefore can be located at any convenient point from which their field operations are dispatched. Examples of this are the geodetic survey, topographic survey, and aeromagnetic surveys, which are based at headquarters in Ottawa. Table 2 lists the main units of the Department with their locations and the approximate expenditures of each for the year 1966-67. Figures for this year were immediately available, and while there have been some changes, such as the commencement of the Canada Centre for Inland Waters at Burlington, Ontario, the broad distribution remains substantially the same in 1968-69.

Factors which should be considered in the decision to locate a scientific operation in a particular centre would include the following:

1. Scientific Contacts

Most scientists find that contact with others of their own discipline and interests is essential if a vigorous level of output is to be maintained. Ease of communication and access to other scientific groups is an important consideration in the location of a scientific establishment.

2. Library

The existence of a relevant library in the area or the opportunity to develop a joint facility with other groups who are interested in similar fields can be a major consideration.

3. Availability of Supplies, Equipment, and Services

Activities involving either the development or the use of complex modern equipment may be seriously impeded by delays in obtaining needed items. Similarly, if special equipment breaks down, the whole operation may be jeopardized unless competent maintenance is available. For these reasons, it may impose a handicap to locate a scientific unit in a place which is inaccessible to the main industrial centres of the nation.

4. Ease of Access

Since personal contact with others in related fields of endeavour is an important element of both production and dissemination of scientific results, good airline and other communication services are essential, both to permit staff travel and to encourage visitors.

5. Critical Size

In most, if not all, scientific endeavour it has been found that efficiency and effectiveness suffer if there are too few individuals interacting and stimulating one another. Therefore groups should not be dispersed to the point where any of them becomes too small to function effectively.

6. Living Conditions

The recruitment and maintenance of staff will be affected by factors such as the cost and availability of housing, the quality of schools, the variety and price of goods available for shopping, recreational facilities, climate, and access to other centres.

In addition to considerations such as these which apply to any type of scientific activity, investigations in the earth sciences may have optimum locations that depend upon the physical features to be studied. The next factor, therefore, is:

7. Access to the Area of Study

At the Bedford Institute, Dartmouth, Nova Scotia, for example, the ocean, the ships, and the laboratories are readily accessible to the scientists. It would be much less efficient if the scientists maintained their laboratories in Ottawa and had to transport complicated equipment to Nova Scotia each time an expedition was undertaken. Similarly, the geologists at the Institute in Calgary are in close contact, not only with the area of their investigations, but also with geologists and executives of oil companies based there. This is an advantage to both the scientists and the community which they serve. Regional officers of the Water Survey of Canada are established across the country because of the obvious need for access to their area of study.

Within the limits imposed by considerations such as these, it is the policy of the Department to locate its new units where their activities can be carried on most effectively and efficiently. Present expectations are that this will lead to progressive decentralization both of personnel and activities, and of operational control in the years immediately ahead.

APPENDIX 4

The statutory basis of the Department's mission and functions is contained in Section 29 of the Government Organization Act, 1966, and in the Resources and Technical Surveys Act.

Government Organization Act

29. The duties, powers and functions of the Minister of Energy, Mines and Resources extend to and include all matters over which the Parliament of Canada has jurisdiction, not by law assigned to any other department, branch or agency of the Government of Canada, relating to

(a) energy, mines and minerals, water and other resources,

(b) explosives, and

(c) technical surveys within the meaning of the Resources and Technical Surveys Act.

Resources and Technical Surveys Act

1. This Act may be cited as the Resources and Technical Surveys Act.

2. In this Act

(a) "Department" means the Department of Energy, Mines and Resources;

(b) "Minister" means the Minister of Energy, Mines and Resources, and

(c) "technical surveys" means geographical, geological, geodetic, topographical and hydrographic surveys.

3-5. Repealed

6. The Minister shall

(a) collect and publish full statistics of the mineral production and of the mining and metallurgical industries of Canada, and such data regarding the economic minerals of Canada as relate to the processes and activities connected with their utilization, and collect and preserve all available records of mines and mining works in Canada;

(b) make detailed investigations of mining camps and areas containing economic minerals or deposits of other economic substances, for the purpose of determining the mode of occurrence, and the extent and character of the ore-bodies and deposits of the economic minerals or other economic substances;

(c) make a full and scientific examination and survey of the geological structure and mineralogy of Canada;

(d) make such chemical, mechanical, metallurgical and other researches and investigations as are necessary or desirable to carry out the purposes and provisions of this Act and particularly to aid the mining and metallurgical industry of Canada;

(e) have the control, management and administration of any astronomical observatories maintained by the Government of Canada;

(f) collect and prepare for exhibition such specimens of the different ores and associated rocks and minerals of Canada and other materials as are necessary to afford a knowledge of the geology and mineralogy and the mining and metallurgical resources and industries of Canada; and

(g) prepare and publish such maps, plans, sections, diagrams and drawings as are necessary to illustrate and elucidate any reports of investigations and surveys made pursuant to this Act.

7. The Minister may, for the purpose of obtaining a basis for the representation of the mineral and mining resources and of the geographical and geological features of any part of Canada, cause such measurements, observations, investigations and physiographic, exploratory and reconnaissance surveys to be made as are necessary for or in connection with the preparation of maps, sketches, plans sections or diagrams.

8A. Subject to section 29 of the Government Organization Act, 1966 respecting the duties, powers and functions of the Minister in relation to matters mentioned in that section over which the Parliament of Canada has jurisdiction, the Minister shall be responsible for co-ordinating, promoting and recommending national policies and programs with respect to energy, mines and minerals, water and other resources, and in carrying out his responsibilities under this section, the Minister may

(a) conduct applied and basic research programs and investigations and economic studies in relation to such resources, and for that purpose maintain and operate research institutes, laboratories, observatories and other facilities for exploration and research related to the source, origin, properties, development or use of such resources; and

8A. (b) study, keep under review and consider recommendations with respect to matters relating to the exploration for, or the production, recovery, manufacture, processing, transmission, transportation, distribution, sale, purchase, exchange or disposition of, any such resources and matters relating to the sources thereof within or outside Canada.

8B. (1) In carrying out his responsibilities under section 8A, the Minister may formulate plans for the conservation, development and use of the resources specified in that section and for research with respect thereto, and with the authority of the Governor in Council and in cooperation with other departments, branches and agencies of the Government of Canada, provide for carrying out such plans.

(2) The Minister may cooperate with the provinces and with municipalities in formulating and carrying out any plans under subsection (1).

(3) In carrying out his duties and functions under this section, the Minister may consult with and inaugurate conferences of representatives of producers, industry, the universities, labour and provincial and municipal authorities.

The responsibilities of the Department which have been described in the text as developing a sound basis for the management of resources and energy are explicitly authorized by sections 8A and 8B of the Resources and Technical Surveys Act. Subsection 8B(1), where it states that the Minister may "provide for carrying out such plans", also authorizes the responsibilities listed under item 3 of the mission, which encompasses the responsibilities of the Federal Government for the administration and management of certain resources, and the disbursement of Federal funds for related purposes.

These sections, 8A and 8B, are new, and were added at the time of the reorganization. The older portions of the Act, which refer specifically to the functions of the former Department of Mines and Technical Surveys, are less general and less purposive in nature. In brief summary they provide for

6(a) the collection and publication of data,

(b) the detailed investigation of mining areas,

(c) the scientific study of the geology of Canada,

(d) chemical, mechanical and metallurgical researches,

(e) the management of astronomical observatories,

(f) the collection and preparation of ore specimens for exhibition,

(g) the preparation and publication of maps, and

7. measurements, observations and surveys for the preparation of maps, etc.

The main purpose underlying this list of activities is to promote the "mining and metallurgical resources and industries of Canada". Nevertheless, both geology 6(c) and astronomy 6(e) are authorized as scientific pursuits independent of such considerations. The other scientific studies undertaken by the Department are justified by items 6(d) and 8A(a) in support of its resource-oriented mission.

The important service functions of topographic and hydrographic surveying and mapping are justified because of their essential contribution to the resource mission; they are also specifically authorized by sections 6(g), which assigns responsibility for the preparation of maps, and 7, by which "the Minister may, for the purpose of obtaining a basis for the representation of the mineral and mining resources and of the geographical and geological features of any part of Canada, cause such measurements, observations ... and ... surveys to be made as are necessary for or in connection with the preparation of maps...."

The purpose of the Government in transforming the old Department of Mines and Technical Surveys into the new Department of Energy, Mines and Resources was presented very clearly by the Prime Minister in a letter written in 1966 to the Minister of Energy, Mines and Resources.

In this letter the Prime Minister stressed the need to bring the responsibility for activities in the energy field under the supervision of a single minister, and to have one agency responsible for the co-ordination of policy and advice on all matters pertaining to energy. While the other agencies were to continue to be advisers within the terms of their own legislation, this department was designated the agency of policy development and coordination. It was instructed to examine energy in all its forms and to make sure that national developmental policies were related in the most effective and economic

fashion to Canadian needs.

The Prime Minister also stated that a second basic need which prompted the creation of the new department was for coordination of policy with respect to resources generally. He discussed some of the jurisdictional problems, and stated that the departments should play a prominent role in developing a policy for resources both on land and off-shore.

The formulation of policy for the management of water resources was especially emphasized. The Minister of Energy, Mines and Resources was instructed to coordinate the activities of his department with those of other departments as well as those of the provinces. The department was given specific responsibility for research and studies related to water in the Canadian North, and was instructed to assume a primary and coordinating role in work on water pollution.

With respect to work in other fields, the Prime Minister indicated that the functions of the new department would continue to be those of the former Department of Mines and Technical Surveys.

APPENDIX 5

Interdepartmental and Interagency Committees on which the Department has Representation

Ad hoc Interdepartmental Committee on Travel, Tourism and Recreation Research

Advisory Committee on Defence Industrial Research

Advisory Committee on New Power Sources

Advisory Committee on Structures and Materials Research

Advisory Committee on Northern Development

Advisory Committee on Geophysics

Advisory Committee on Energy Statistics

Advisory Board on the Canadian Oceanographic Data Centre

A.R.D.A. Soils Sub-Committee for British Columbia

N.R.C. Associate Committee on Geodesy and Geophysics

Associate Committee for Aeronautical Structures and Materials

Associate Committee on Meteorites

Associate Committee on Quaternary Research

Associate Committee on Geotechnical Research

Associate Committee on Earthquake Engineering

Associate Committee on Space Research

Associate Committee for The International Union of Scientific Radio

Associate Committee on Environmental Pollution

Associate Committee on Water Pollution Research

Canadian Advisory Committee on Coal Research

Canadian Committee on Stratistics of drilling

Canadian Committee on Oceanography

Canadian Forces Headquarters Committee on Military Oceanography

Committee on Industrial Research Assistance

Committee on X-ray Safety Standards

Committee on Corrosion and Fouling

Committee on St. Lawrence River Tidal Investigations

Copper Controls Committee

Electronic Components Research and Development Committee

FHE 400 Materials Steering Committee

High Strength Naval Materials Committee

Interdepartmental Committee on Air Cushion Vehicles

Interdepartmental Committee on Resources

Interdepartmental Committee on Water (Interim)

Interdepartmental Committee on Atlantic Water Resources Studies (federal segment of a federal-prcvincial group)

Interdepartmental Okanagan Lake Study Group (ad hoc)

Interdepartmental Study Group on Satellites

Interdepartmental Co-ordinating Committee on Technical Programs Relating to Resource Development

Interdepartmental Committee on Wave Climate Studies

Interdepartmental Appraisal Committee for Research Scientists

Interdepartmental Committee on Air Surveys

Interdepartmental Committee on Pesticides

International Lake Erie Water Pollution Board (Canadian Section)

International Lake Ontario and St. Lawrence River Pollution Board (Canadian Section)

Joint Arctic Weather Stations Planning Conference

Magnetic Airborne Detector Committee

National Committee on Forest Land

National Committee on Wildlife Lands

Nickel Controls Committee

OECD Industry Committee (Ottawa Panel)

OECD Energy Committee (Ottawa Panel)

Reactor Safety Advisory Committee

Rotor Forgings Research and Development Committee

Royal Canadian Mint Committee on New Coinage

Seismic Regionalisation and Recent Crustal Movements Committee

Screening Committee on Grants-in-aid of Earth Sciences

Shell Fish Committee

Sub-committee of Visits Panel on Proposals for Arctic Exchanges (External Affairs - arrangements for exchange of visits with the Soviet Union)

Technical Committee for Steel Plates for Ship Construction

Working Group on Steele Glacier

Working Group on Ice and Navigable Waterways (federal segment of a national committee)

International Committees and Agencies on which the Department has Representatives

	Member of Delegate	Technical Advice to Canadian Member	Data or Contribution
Geological Survey of Canada			
International Union of Geological Sciences	x		
Geological Liaison Office, British Commonwealth Scientific Conference			x
International Geological Congress	x		
External Aid Office, Dept. of External Affairs		x	
Pan American Institute of Geography and History	x		
Mines Branch			
British Flame Research Committee	x		
International Briquetting Association	x		
International Committee on Illumination	x		
International Electrotechnical Commission (2 committees)	x		
International Institute of Welding	x		
International Joint Commission	x		
International Mineralogical Association	x		
International Mining Congress	x		
International Organization for Standardization (8 committees)	x		
International Union for Crystallography (2 committees)	x		
International Union of Pure and Applied Chemistry (2 committees)	x		
North Atlantic Treaty Organization		x	
Organization for Economic Cooperation and Development (9 committees)	x		
Standing Committee for International Cooperation in the Field of Non-Destructive Testing	x		
The Technical Cooperation Program (4 committees)	x		
World Power Conference	x		
National Fire Protection Association	x		

	Member or Delegate	Technical Advice to Canadian Member	Data or Contribution
Mines Branch (cont'd)			
Society for Nondestructive Testing	x		
The Magnesium Association	x		
Welding Research Council	x		
Commonwealth Advisory Aeronautical Research Council	x		
Surveys and Mapping Branch			
NATO Topographic Mapping (through Department of National Defence		x	x
Pan American Institute of Geography and History	x		
Observatories Branch			
International Astronomical Union U.S. Coast and Geodetic Survey, Earthquake Center	x		x
Central Bureau, International Association of Seismology			x
Central Bureau of USSR Seismic Network			x
International Seismological Center, Edinburgh			x
Swedish National Defence Research Institute			x
Members of "Nuclear Detection Club" (secondary powers interested in distinguishing blasts from earthquakes)			x
International Union of Geodesy and Geophysics	x		
International Association of Seismology and Physics of the Earth's Interior	x		
International Association of Geo-magnetism and Aeronomy	x		
International Union of Geodesy	x		
Data Centres Maintained by Upper Mantle Committee of International Union of Geodesy and Geophysics--International Union of Geological Sciences			x
International Gravimetric Bureau			x

	Member or Delegate	Technical Advice to Canadian Member	Data or Contribution
Observatories Branch (cont'd)			
International Gravimetric Commission			x
Geomagnetic World Data Centre (Washington)			x
Bureau International de l'Heur (Paris)			x
International Latitude Service (Paris)			x
International Polar Motion Centre (Tokyo)			x
National Aeronautical and Space Administration (Washington)			x
Mineral Resources Branch			
International Lead and Zinc Study Group	x		
Subcommittee of the Statistical Committee	x		
Working Party on Joint Occurrence of Lead and Zinc	x		
OECD Special Committee for Iron and Steel	x		
Various special studies	x		
Iron and Steel Committee of the United Nations Economic Commission for Europe		x	
International Tin Council		x	
United Nations Tungsten Committee	x		
OECD European Nuclear Energy Study Group on the Long Term Rate of Nuclear Energy Development in Western Europe	x		
Marine Sciences Branch			
International Hydrographic Bureau	x		
International Oceanographic Commission	x		
NATO Subcommittee on Oceanic Research	x		
Coordinating Group on Great Lakes Base Hydraulics and Hydrological Data Vertical Controls Subcommittee	x		
International Tsunami Coordinating Group in the Pacific Ocean			

	Member of Delegate	Technical Advice to Canadian Member	Data or Contribution
Marine Sciences Branch (Cont'd)			
International Commission for the Northwest Atlantic Fisheries (ICNAF)		x	
International Northwest Pacific Fisheries Commission (INPFC)		x	
Scientific Committee for Oceanic Research (SCOR) (Member nominated by CCO)	x		
International Council for the Exploration of the Sea Hydrographic Committee	x		
General Bathymetric Chart of the Oceans			x
Inland Waters Branch			
International Hydrological Decade 28 projects	x	x	
International Joint Commission (IJC) 19 projects	x	x	
Editing Committee	x		
U.S.-Canada Boundary Water Projects (assigned by Department of External Affairs) - 6 projects	x		
World Meteorological Organization Commission for Hydrometeorology	x		
International Standards Organization	x		
Energy Development Sector			
St. John River Engineering Committee (U.S.-Canada)	x	x	x
Power System Engineering Committee, Inst. of Electrical and Electronic Engineers	x	x	x
NATO Wartime Oil Organization		x	
Organization for Economic Cooperation and Development - Energy Committee		x	
World Energy Conference - Canadian Committee	x		
Columbia River Treaty Permanent Engineering Board (U.S.-Canada)	x		

	Member or Delegate	Technical Advice to Canadian Member	Data or Contribution
Energy Development Sector (Cont'd)			
Canadian delegations engaged in international negotiations concerning the offshore, e.g. Canadian-France boundary		x	x
U.N. Committee on Seabed		x	x
Intergovernment Maritime Consultative Organization on Safety of Navigation		x	x
General			
International Council of Scientific Unions	x		

APPENDIX 6

Studies of Departmental Organization and Procedure

Twelve studies which have been made by outside agencies in the past five years are listed in reverse chronological order. The latest study, number one, was the most comprehensive and supercedes a number of those preceding. The Department is at present reviewing the recommendations and considering steps to implement those which are accepted. Implementation of the recommendations arising from some of the earlier studies was interrupted or made irrelevant by the incorporation of the old Department of Mines and Technical Surveys into the new Department of Energy, Mines and Resources in 1966.

1. In mid-1967 the Bureau of Management Consulting Services, Public Service Commission, undertook a detailed study of the organization, administration, management, and requirements of the Department under the following broad headings:

   1) Organization of the Department
   2) Financial Management and Administrative Services
   3) Personnel Organization and Functions
   4) Long-Range Planning
   5) Data Processing Facilities and Requirements.

   A comprehensive report on the results of this study was submitted in September, 1968. It includes several interim and final reports which had previously been submitted on portions of the study.

2. Work Scheduling of Rapid Method Analysis, by Management Analysis Division, Civil Service Commission, June 1967 -

   The Geological Survey of Canada requested advice on the most efficient method of scheduling the chemical analysis of rock samples. A comparison was made between the "batch" method and the "assembly line" method for several periods

of staff rotation. The "assembly line" method with four week staff rotation period was shown to be superior and was recommended. It was estimated to give a maximum output of 2,350 samples per year.

3. Organization Study of the Department of Energy, Mines and Resources by Organization Division, Civil Service Commission, July 1966 - K. Pond

The study was undertaken as a result of the establishment of the Department of Energy, Mines and Resources proclaimed by the Prime Minister in December 1965. It was "to determine the top structure of the Department and the division of labour which would be most appropriate and organizationally sound to meet the Department's objectives."

4. The Authorized Projects System for the Surveys and Mapping Branch of the Department of Mines and Technical Surveys by P.S. Ross & Partners, June 1966 -

This report covers a system for maintaining a file of authorized projects on a computer in which will be recorded labour and material costs for each phase of a project as well as due dates and completion dates for the phases. The output of the system will be performance reports and cost reports for the operating areas as well as project progress reports.

5. Inventory Control and Automatic Mailing for the Surveys and Mapping Branch, Department of Mines and Technical Surveys by P.S. Ross & Partners, February 1966 -

The report described the detailed design of a series of systems and programs to provide computerized inventory control and automatic mailing of maps and charts to agents and dealers, including lithographic production reports and a monthly list of publications.

6. Feasibility Study for Integrated Shipboard Data Processing System, Phases I and II and final report by Computing Devices of Canada Limited, August 2, 1965, February 2, 1966 and March 21, 1966 -

The study was reported in five volumes of which only three are available. The fourth dealt with Hydrographic methods used by foreign agencies. The fifth discussed hydrographic and oceanographic equipment. The requirement for defining a data-collecting and processing system for a single ship with combined hydrographic and oceanographic capabilities introduced extensive complications into the study. However, during Phase I, plans for the vessel changed and it was indicated that Phase II should concentrate on hydrographic methods and procedures. Report number 6513/R2, then, outlined an integrated data processing system which would meet the requirements of a vessel capable of both oceanographic and hydrographic work. In the next report, number 6513/R4, current methods and the history of the Canadian Hydrographic Service were examined and possible improvements were suggested. The last report, number 6513/R6, discussed hydrographic system philosophy, field and chart-making requirements and costs. Finally, a recommended approach to incorporating an improved hydrographic system into the Marine Sciences Branch was outlined and a development group for planning and scheduling was recommended.

7. Organization Study of the Mines Branch, Department of Mines and Technical Surveys by Organization Division, Civil Service Commission, June 1965 -

The study recommended that the Department of Mines and Technical Surveys:

(a) re-assess the advantages of maintaining the Mineral Resources Division outside the Branch;

(b) seek closer cooperation with the Department of Industry;

(c) establish a national Advisory Council concerned with the responsibilities of the Branch;

(d) review its existing programming and charging arrangements;

(e) establish a position of Assistant Director to relieve the Director of a portion of his excessive work-load; and

(f) institute closer cooperation with universities.

8. A Study of Computer System Requirements for Department of Mines and Technical Surveys by Stevenson Kellog Limited, May 1965 -

The study attempted to identify the data processing and computational requirements of the Department, including Bedford Institute of Oceanography and Yellowknife Array, for the following 5 years, and recommended computer systems and services to meet these requirements.

9. Organization Study of the Mines Branch, Department of Mines and Technical Surveys by Organization Division, Civil Service Commission, May 1965 -

Included the reorganization of Mines Branch and recommended the Branch reassess its position with respect to outside agencies with a view to lowering the "psychological height of its division and branch boundaries" so as to facilitate the interchange of scientific data with other agencies both within and outside the Government of Canada. Also recommended establishment of a National Advisory Council concerned with the work of the Mines Branch, and extended assistance to universities.

10. Organization Survey of Department of Mines and Technical Surveys by Organization Division, Civil Service Commission, December 1964 -

Recommended sweeping changes in the Department ranging from revision of the Act and changing the Department's name to the union of the Geographical Branch and the Surveys and Mapping Branch. Map Compilation and Reproduction were to become the nucleus of a Technical Services Branch under a Director General of Support Services having separate Technical and Administration Branches. Also recommended dividing the Personnel and Organization Branch into "people-oriented" and "work-oriented" branches with the former becoming the whole of the Directorate of Personnel and the latter becoming a part of the Administration services under a Director-

General of Support Services. Also included a reorganization of the Mines Branch, with inclusion of Mineral Resources as a Division, as well as a survey of the Air Photographic Unit, and a survey of the Geological Survey Branch.

11. Report on a Study of the Property and Building Management Division, Administration Branch, Department of Mines and Technical Surveys by Management Analysis Division, Civil Service Commission, November 1964 -

Recommended a complete reorganization of the Division, including redistribution of functions and activities and an an increase in establishment.

12. Report on a Survey to Establish Work Standards in Department of Mines and Technical Surveys, Administration Branch, Special Administrative Services Division by Management Analysis Division, Civil Service Commission, October 1964 -

Recommended a work sheet (form) and work standards for use in Key Punch and Verifying Units. Could not recommend work standards for programming.

TABLE 1

The Sectors, Branches and Divisions of the Department

	Establishments (Full-time staff)		
MINES AND GEOSCIENCES SECTOR			2445
Geological Survey of Canada Branch		539	
Branch Administration and Technical Services	149		
Crustal Geology	109		
Exploration Geophysics	56		
Geochemistry, Mineralogy and Economic Geology	84		
Institute of Sedimentary and Petroleum Geology	88		
Quarternary Research and Geomorphology	53		
Mines Branch		714	
Administration	45		
Technical Services	81		
Extraction Metallurgy	92		
Mineral Processing	100		
Mineral Sciences	91		
Physical Metallurgy	156		
Fuels Research	90		
Mining Research	59		
Surveys and Mapping Branch		946	
Branch Administration	98		
Geodetic Survey Division	58		
International Boundary Commission	6		
Topographic Survey Division	280		
Legal Surveys Division	132		
Map Compilation and Reproduction Division	266		
Atlas of Canada Division	37		
Air Photo Production Division	69		

Observatories Branch		223	
Administration	27		
Geomagnetic	41		
Gravity	34		
Astronomy	28		
Seismology	44		
Dominion Radio Astronomical Observatory	12		
Dominion Astrophysical Observatory	26		
Mt. Kobau	11		
Polar Continental Shelf Project		23	
MINERAL DEVELOPMENT SECTOR			96
Mineral Resources Branch		84	
Director and Administration	32		
Commodities	22		
Research and Planning	24		
Taxation and Legislation	6		
WATER SECTOR			1911
Marine Sciences Branch		1010	
Branch Headquarters	277		
Pacific Region	116		
Central Region	80		
Atlantic Region	537		

NOTE: While the foregoing represents the main operational organization, the activities are more clearly divided as follows:

Administration and Support Services	195
Hydrography	321
Oceanography	194
Ship Operations	300

Inland Waters Branch		777
Branch Administration	91	
Water Survey of Canada	328	
Engineering	93	
Great Lakes	114	
Hydrologic Sciences	90	
Water Quality	61	
Policy and Planning Branch		121
Branch Administration	34	
Policy Advisory, Coordination and Administration	13	
Planning	26	
Resources Research Centre	48	
ENERGY DEVELOPMENT SECTOR		26

TABLE 2

Location of Principal Units of the Department Outside Ottawa, Showing Approximate Expenditures

	Approx. Expenditures 1966-7 $000's
Victoria	
Pacific Regional Office (Marine Sciences Branch)	5,151
Dominion Astrophysical Observatory	2,345
	7,496
Vancouver	
Inland Waters Branch District Office	972
Geological Survey Regional Office	208
	1,180
Calgary	
Inland Waters Branch District Office	916
Institute of Sedimentary and Petroleum Geology (Geological Survey)	501
	1,417
Edmonton	
Mines Branch Western Region Laboratories	60
Winnipeg	
Inland Waters Branch District Office	473
Guelph	
Inland Waters Branch District Office	441
Ottawa	
Mines Branch	6,594
Geological Survey of Canada	8,987
Surveys and Mapping Branch	6,764
Observatories Branch	3,041
Polar Continental Shelf Project	1,899
Marine Sciences Branch	3,429
Policy and Planning Branch	141
Inland Waters Branch	2,417
Geographical Branch	1,073
Mineral Resources Division	594
Departmental Administration	3,168
	38,107
Elliot Lake	
Mining Research Laboratory (Mines Branch)	180
Montreal	
Inland Waters Branch Area Office	46
Glace Bay	
Eastern Region Mining Research Office (Mines Branch)	16
Halifax	
Inland Waters Branch District Office	279
Dartmouth	
Atlantic Oceanographic Laboratory (Marine Sciences Branch)	7,545
Whitehorse	
Territorial Geological Office (Geological Survey)	28
Yellowknife	
Territorial Geological Office (Geological Survey)	29
Total, Department	57,297

TABLE 3

Current personnel establishment and people on strength by category of personnel and by Sector.

UNIT	OCCUPATIONAL GROUP	ESTABLISHMENT Cont.	ESTABLISHMENT Seas.	STRENGTH Cont.	STRENGTH Seas.
	Mineral Development Sector				
ADM MIN DEV.	Scient. & Prof. ...	1		1	
MIN RES BR.	Scient. & Prof. ...	40		37	
	Admin & For. Service ...	6		4	
	Technical	11		7	
	Admin. Suppt. ...	30		27	
	Operational ...	1		1	
EXPLOS DIV.	Scient. & Prof. ...	7		*7	
	Admin. Suppt. ...	9		9	
QUEBEC OFFICE	Scient. & Prof. ...	1		1	
	Mines and Geosciences Sector				
ADM MINES & GEOSC.	Scient. & Prof. ...	2		2	
MINES BRANCH	Scient. & Prof. ...	282		257	
	Admin & For. Service ...	12		11	
	Technical ...	271		217	
	Admin. Suppt. ...	75		75	
	Operational ...	120		114	
GEO. SURVEY	Scient. & Prof. ...	245		215	
	Admin & For. Service ...	13		5	
	Technical ...	179		165	
	Admin. Suppt. ...	76		69	
	Operational ...	26	(54)	18	(54)
SURV. & MAP. BR.	Scient. & Prof. ...	157		**129	
	Admin & For. Service ...	16		8	
	Technical ...	571		515	
	Admin. Suppt. ...	81		73	
	Operational ...	121	(198)	114	(198)

UNIT	OCCUPATIONAL GROUP	ESTABLISHMENT Cont.	ESTABLISHMENT Seas.	STRENGTH Cont.	STRENGTH Seas.
OBSERV. BR.	Scient. & Prof. ...	97		89	
	Admin & For.				
	Service ...	3		3	
	Technical ...	74		65	
	Admin. Suppt. ...	29		28	
	Operational ...	10	(15)	10	(15)
POLAR CONT. SHELF PROJ.	Scient. & Prof. ...	22		17	
	Admin & For.				
	Service ...	2		1	
	Technical ...	11		7	
	Admin. Suppt. ...	4		4	
	Operational ...	4	(12)	4	(12)
	Water Sector				
ADM WATER	Scient. & Prof. ...	1		1	
MARINE SCIEN. BR.	Scient. & Prof. ...	130		105	
	Admin & For.				
	Service ...	33		22	
	Technical ...	543		485	
	Admin. Suppt. ...	133		116	
	Operational ...	195	(485)	677	(485)
INLAND WATERS BR.	Scient. & Prof. ...	246		194	
	Admin & For.				
	Service ...	30		16	
	Technical ...	322		283	
	Admin. Suppt. ...	133		107	
	Operational ...	18		17	
POLICY & PLAN. BR.	Scient. & Prof. ...	61		33	
	Admin & For.				
	Service ...	5		5	
	Technical ...	21		5	
	Admin. Suppt. ...	33		21	
	Operational ...	0		0	
	Energy Sector				
ADM ENERGY DEV.	Scient. & Prof. ...	1		1	
ENERGY ADVRS.	Scient. & Prof. ...	1		1	
TOTALS	....	4469	(764)	4388	***(764)

(These figures do not include 384 continuing positions attached to units not conducting scientific activities.)

DEPARTMENTAL ESTABLISHMENT TOTALS C=4853 S=(764) GRAND TOTAL ...5617

NOTE:

* one incumbent classified as a professional, not possessing a university degree.

** Fifteen incumbents classified as a professional, not possessing a university degree. (Land surveyors credentials).

*** Establishment (Position) totals used

TABLE 4

Current headquarter's establishment and people on strength, who are not considered to be conducting scientific activities.

DEPARTMENTAL HEADQUARTERS - ADMINISTRATION

UNIT	ESTABLISHMENT	STRENGTH
Deputy Minister & Staff	10	9
Assistant Deputy Minister's Staff		
Assistant Deputy Minister Mines & Geosciences	5	5
Assistant Deputy Minister Mineral Development	4	4
Assistant Deputy Minister Water	4	3
Assistant Deputy Minister Energy Development	8	7
	(31)	(28)
Financial Services Division	11	9
Public Relations and Information Services	39	33
Computer Sciences Division	73	53
Director of Administration	136	113
Personnel and Organization	94	82
TOTALS	*384	*318

* These totals do not include a total of 7 positions and incumbents which were shown with that professional group considered to be conducting scientific activities.

TABLE 5

Current headquarter's establishment and people on strength, who are considered to be conducting scientific activities.

These positions are as follows:

POSITION	ESTABLISHMENT	STRENGTH
Assistant Deputy Minister Mines & Geosciences	1	1
Senior Scientific Adviser	1	1
Assistant Deputy Minister Mineral Development	1	1
Senior Scientific Officer - Quebec Office	1	1
Assistant Deputy Minister Energy Development	1	1
Senior Adviser Electrical Energy	1	1
Assistant Deputy Minister Water	1	1
TOTALS	7	7

TABLE 6

Department Totals

	ESTABLISHMENT	STRENGTH
Continuing	4853	4706
Seasonal	764	*500 (App)
TOTALS	5617	5206 (App)

* A precise figure for total seasonal strength would be most difficult to obtain. Due to the nature of this classification the strength varies daily. During the summer months strength would approach 100%.

TABLE 7

Number of guest workers, staff-on-loan, post-doctorate fellows, by Sector

UNIT	GUEST WORKERS	STAFF-ON-LOAN (EMP)	-- (NON EMP)	POST-DOCTORATE FELLOWS
		Mineral Development Sector		
ADM MIN DEV.	0	0	0	0
MIN RES BR.	0	0	0	0
EXPL. DIV.	0	0	0	0
QUE. OFFICE	0	0	0	0
		Mines and Geosciences Sector		
ADM MINES & GEO-SCIEN.	0	0	0	0
MINES BR.	0	0	0	10
GEOL. SURVEY	2	1	0	7
SURV. & MAP. BR.	0	2	0	0
OBSERV. BR.	0	0	0	8
POLAR CONT. SHELF PROJ.	0	0	0	0
		Water Sector		
ADM WATER	0	0	0	0
MARINE SCIEN. BR.	0	0	0	3
INLAND WATERS BR.	0	0	0	2
POL. & PLAN. BR.	0	1	0	0
		Energy Sector		
ADM ENERGY DEV.	0	0	0	0
ENERGY ADVRS.	0	0	0	0
GRAND TOTALS	2	4	0	30

TABLE 8

Number of professional staff devoting most of their time to administrative duties, by Sector.

UNIT	NUMBER	UNIT	NUMBER
Mineral Development Sector			
ADM MIN DEV.	1	MIN RES BR.	1
EXPL. DIV.	2	QUE. OFFICE	1
Mines and Geosciences Sector			
ADM MINES & GEOSCIEN.	2	POLAR CONT. SHELF PROJ.	1
MINES BR.	20	GEOL. SURVEY	21
SURV & MAP. BR.	13	OBSERV. BR.	6
Water Sector			
ADM WATER	9	POL. & PLAN BR.	9
MARINE SCIEN. BR.	10	INLAND WATERS BR.	42
Energy Sector			
ADM ENERGY DEV.	1	ENERGY ADVSRS.	1
		GRAND TOTAL	132

TABLE 9

Professional staff associated with scientific activities; number in each degree category for years 1962 to 1968, by Sector.

UNIT	DEGREE CATEGORY		1962	63	64	65	66	67	68
					YEAR				
			Mineral Development Sector						
ADM	Bachelor	-	1	1	1	1	1	1	1
MIN	Master	-							
DEV.	Ph.D.	-							
MIN	B.	-	12	13	15	16	18	21	24
RES	M.	-	4	4	4	4	6	8	11
BR.	P.	-	1	1	1	1	2	2	4
EXPL.	B.	-	6	6	6	6	6	6	6
DIV.	M.	-							
	P.	-							
QUE.	B.	-							
OFFICE	M.	-							
	P.	-							
			Mines and Geosciences Sector						
ADM	B.	-							
MINES &	M.	-							
GEOSCIE.	P.	-	2	2	2	2	2	2	2
MINES	B.	-	144	146	145	142	148	150	151
BR.	M.	-	31	29	31	37	38	39	40
	P.	-	50	50	50	54	62	61	63
GEOL.	B.	-	39	36	36	36	30	30	32
SURV.	M.	-	17	13	17	16	17	18	19
	P.	-	136	140	140	151	143	147	143
SURV. &	B.	-	*	*	*	*	*	*	64
MAP. BR.	M.	-	*	*	*	*	*	*	7
	P.	-	*	*	*	*	*	*	1
OBSERV.	B.	-	30	28	30	32	35	39	42
BR.	M.	-	18	19	20	22	24	29	28
	P.	-	17	20	18	29	28	34	35
POLAR	B.	-	13	11	11	10	9	9	9
CONT.	M.	-	0	1	1	3	3	4	4
SHELF	P.	-	5	6	6	5	5	5	5
PROJ.									

(Continued)

UNIT	DEGREE CATEGORY		YEAR 1962	63	64	65	66	67	68
					Water Sector				
ADM	B.	-							
WATER	M.	-						1	1
	P.	-							
MAR	B.	-	40	41	35	28	28	32	35
SCIEN.	M.	-	10	14	13	20	19	22	27
BR.	P.	-	6	11	14	20	26	34	39
INLAND	B.	-						**97	109
WATERS	M.	-						**26	30
BR.	P.	-						**30	37
POL. &	B.	-						***13	15
PLANN.	M.	-						*** 9	12
BR.	P.	-						*** 3	5
					Energy Sector				
ADM	B.	-						**** 1	1
ENERGY	M.	-							
DEV.	P.	-							
ENERGY	B.	-						***** 1	1
ADVSRS.	M.	-							
	P.	-							
GRAND	B.	-	285	282	279	271	275	400	490
TOTALS	M.	-	81	81	87	104	109	157	180
	P.	-	217	230	231	262	268	318	334

*(S&M BR) No records available prior to 1968
**(IW BR) Did not exist prior to 1967
***(P&P BR) Did not exist prior to 1967
****(ADM ENERGY DEV) Did not exist prior to 1967
*****(ENERGY ADVSRS) Did not exist prior to 1967

TABLE 10

Percentage of *turnover of professional staff in the three degree categories for each of the years 1962 to 1967.

*Turnover for the purpose of this study should be interpreted as meaning those personnel leaving the employ of the department during the years indicated.

UNIT	DEGREE CATEGORY	YEAR 1962	1963	1964	1965	1966	1967
				Mineral Development Sector			
ADM MIN DEV.	Bachelor						
	Master						
	Phd.						
MIN RES BR.	B.		7.		6.	5.	4.
	M.	25.		25.		25.	8.
	P.				50.		25.
EXPLO. DIV.	B.			16			
	M.						
	P.						
QUE. OFFICE	B.						
	M.						
	P.						
				Mines and Geosciences Sector			
ADM MINES & GEOSCIE.	B.						
	M.						
	P.						
MINES BR.	B.	2.1	4.3	5.8	4.5	2.6	0.7
	M.			3.2	2.7	5.3	9.5
	P.	4.2	7.4	4.2	2.2	7.1	7.0
GEOL. SURV.	B.	2.6	11.1	5.5	8.3	20.0	
	M.		5.9	7.7	5.9	3.5	5.6
	P.		.8	2.8	3.9	11.9	4.
SURV. & MAPP. BR.	B.	3.	3.	3.	3.	3.	3.
	M.						
	P.						
OBSERV. BR.	B.	1.	.5	.5	1.2	1.	1.
	M.	1.	.5	.5	1.2	1.	1.
	P.	1.	.5	.5	1.2	1.	1.
POLAR CONT. SHELF PROJ.	B.						
	M.						
	P.				20.		
				Water Sector			
ADM WATER	B.						
	M.						
	P.						
MAR. SCIEN. BR.	B.	3.	2.	16.	25.	4.	13.
	M.			15.			
	P.					4.	6.
INLAND WATERS BR.	B.						8.
	M.						11.
	P.	No estab. prior to 1967					10.

...2

- 2 -

POL. & PLANN. BR.	B. M. P.	No estab. prior to 1967					10.
		Energy Sector					
ADM ENERGY DEV.	B. M. P.						
ENERGY ADVSRS.	B. M. P.						
DEPT.% AVERAGE	B. M. P.	.7 1.6 .3	1.7 .4 .5	2.9 2. .5	3. .6 4.8	2.9 2.2 1.5	3.1 2.8 3.3

TABLE 11

Number of staff in each degree category on education leave.

UNIT	DEGREE CATEGORY	-1968-
	Mineral Development Sector	
ADM MIN DEV.	Bachelor	-
	Master	-
	Phd.	-
MIN RES BR.	B.	-
	M.	-
	P.	1
EXPL. DIV.	B.	-
	M.	-
	P.	-
QUE. OFFICE	B.	-
	M.	-
	P.	-
	Mines and Geosciences Sector	
ADM MINES & GEOSCIE.	B.	-
	M.	-
	P.	-
MINES BR.	B.	4
	M.	-
	P.	-
GEOL. SURV.	B.	-
	M.	1
	P.	-
SURV. & MAPP. BR.	B.	3
	M.	2
	P.	-
OBSERV. BR.	B.	2
	M.	6
	P.	1
POLAR CONT. SHELF PROJ.	B.	1
	M.	-
	P.	-
	Water Sector	
ADM WATER	B.	-
	M.	-
	P.	-
MAR. SCIEN. BR.	B.	1
	M.	4
	P.	-
INLAND WATERS BR.	B.	5
	M.	3
	P.	-
POL. & PLANN. BR.	B.	-
	M.	-
	P.	-

...2

- 2 -

Energy Sector

ADM ENERGY DEV.	B.	-
	M.	-
	P.	-
ENERGY ADVSRS.	B.	-
	M.	-
	P.	-
GRAND TOTALS	B.	16
	M.	16
	P.	1

TABLE 12

Number of university students given summer employment in the field of scientific activities for the years 1962 to 1967.

UNIT	1962	1963	1964	1965	1966	1967
				YEAR		
Mineral Development Sector						
ADM MIN DEV.	0	0	0	0	0	0
MINERAL RES BR.	2	2	4	6	3	2
EXPLOSIVES DIVISION	0	0	0	0	0	0
QUE. OFFICE	0	0	0	0	0	0
Mines and Geosciences Sector						
ADM MINES & GEOSCIEN.	0	0	0	0	0	0
MINES BR.	35	36	37	38	39	41
GEOLOGICAL SURVEY	288	303	308	314	281	283
SURV. & MAPP. BR.	125	125	125	125	125	125
OBSERV. BR.	34	35	35	40	40	42
POLAR CONT. SHELF PROJ.	0	0	0	0	0	0
Water Sector						
ADM-WATER	0	0	0	0	0	0
MARINE SCIEN. BR.	0	1	0	4	14	38
INLAND WAT. BR.	*No estab. prior to 1967					*92
POLICY & PLANN. BR.	*No estab. prior to 1967					*11
Energy Sector						
ADM-ENERGY DEVELOP.	*No estab. prior to 1967					* 0
ENERGY ADVSRS	*No estab. prior to 1967					* 0
GRAND TOTALS	484	502	509	527	502	634

TABLE 13

Expenditures associated with scientific activities

Funds expended to further professional university education of staff for each of the fiscal years from '62-'63 to '68-'69 inclusive (e.g. costs of educational leave to take higher degree, payments to cover costs of taking courses at local universities).

UNIT	1962-63	63-64	64-65	65-66	66-67	67-68	68-69
			Mineral Development Sector				
ADM MIN DEV.	0	0	0	0	0	0	0
MINERAL RES BR.	$ 3,000	0	$ 143	$ 3,930	$ 6,920	$ 520	$ 2,418
EXPLOSIVES DIVISION	0	0	0	0	0	0	0
QUE. OFFICE	0	0	0	0	0	0	0
			Mines and Geosciences Sector				
ADM MINES & GEOSCIEN.	0	0	0	0	0	0	0
MINES BR.	0	0	0	3,645	7,750	0	13,10C
GEOLOGICAL SURVEY	5,976	8,538	14,832	12,611	4,630	2,769	395
SURV. & MAPP. BR.	0	0	0	0	0	4,400	5,100
OBSERV. BR.	6,500	7,000	7,500	9,000	10,000	13,600	47,000
POLAR CONT. SHELF PROJ.	0	0	0	0	0	0	0
			Water Sector				
ADM WATER	0	0	0	0	0	0	0
MARINE SCIEN. BR.	13,938	8,913	13,639	15,142	17,338	23,960	19,725
INLAND WAT. BR.	* No estab. prior to 1967-68					*27,000	*27,300
POLICY & PLANN. BR.	* No estab. prior to 1967-68					*0	*0
			Energy Sector				
ADM ENERGY DEVELOP.	* No estab. prior to 1967-68					*0	*0
ENERGY ADVSRS.	* No estab. prior to 1967-68					*0	*0
GRAND TOTALS	$29,414	$24,451	$36,114	$44,328	$46,639	$72,249	$115,038

TABLE 14

Highest degree - country of birth - number of professionals associated with scientific activities;

BACHELOR		MASTER		DOCTORATE	
COUNTRY	NO. OF PROF.	COUNTRY	NO. OF PROF.	COUNTRY	NO. OF PROF.
Australia	2	Barbados	1	Australia	2
Canada	403	Canada	132	Austria	2
China (Peoples Rep.)	1	China (Peoples Rep.)	4	Bermuda	1
China (Nationalist)	3	Czechoslovakia	2	Canada	187
Finland	1	Finland	1	China (Peoples Rep.)	4
France	1	Germany (Fed. Rep.)	2	Egypt	2
Germany (Fed Rep)	6	Hungary	4	France	1
Hungary	3	India	4	Germany (East)	2
India	5	Indonesia	1	Germany (Fed. Rep.)	8
Netherlands	1	Iran	1	Greece	1
Poland	4	Ireland	2	Guinea Republic	1
Romania	2	Jamaica	1	Hungary	2
South Africa	2	Netherlands	7	India	15
Spain	1	Pakistan	1	Indonesia	2
United Kingdom	35	Poland	5	Ireland	1
United States	9	Turkey	3	Israel	1
U.S.S.R.	7	United Kingdom	28	Italy	1
Yugoslavia	3	United States	6	Japan	1
		U.S.S.R.	7	Malaysia	1
				Netherlands	10
				New Zealand	5
				Norway	1
				Pakistan	1
				Poland	5
				Romania	1
				South Africa	2
				Switzerland	4
				United Kingdom	73
				United States	15
				U.S.S.R.	9
				Yugoslavia	2
DEGREE TOTAL	489		212		363

TOTAL PROFESSIONALS - 1064

TABLE 15

Highest degree - country in which secondary education taken, number of professionals associated with scientific activities;

BACHELOR		MASTER		DOCTORATE	
COUNTRY	NO. OF PROF.	COUNTRY	NO. OF PROF.	COUNTRY	NO. OF PROF.
Australia -	2	Barbados -	1	Australia -	2
Canada -	433	Belgium -	1	Austria -	1
China (Peoples Rep) -	1	Bermuda -	1	Bermuda -	1
France -	2	Canada -	143	Canada -	216
Germany (East) -	1	China (Peoples Rep) -	4	China (Peoples Rep) -	3
Germany (Fed. Rep.) -	3	Czechoslovakia -	1	Egypt -	2
Hungary -	4	Germany (Fed. Rep.) -	2	France -	2
India -	4	Hungary -	5	Germany (Fed. Rep.) -	7
Poland -	2	India -	4	Germany (East) -	2
Romania -	1	Indonesia -	1	Greece -	1
South Africa -	2	Iran -	1	Hungary -	2
United Kingdom -	26	Ireland -	1	India -	14
United States -	3	Jamaica -	1	Indonesia -	1
U.S.S.R. -	2	Netherlands -	6	Japan -	1
Yugoslavia -	3	Pakistan -	1	Netherlands -	10
		Poland -	3	New Zealand -	5
		Turkey -	3	Norway -	1
		United Kingdom -	22	Poland -	3
		United States -	6	South Africa -	3
		U.S.S.R. -	4	Sweden -	1
		Yugoslavia -	1	Switzerland -	4
				United Arab Rep. -	1
				United Kingdom -	66
				United States -	9
				U.S.S.R. -	3
				Yugoslavia -	2
DEGREE TOTAL	489		212		363

TOTAL PROFESSIONALS - 1064

TABLE 16

Country in which degree was taken - number of professionals associated with scientific activities in each degree level;

BACHELOR		MASTER		DOCTORATE	
COUNTRY	NO. OF PROF.	COUNTRY	NO. OF PROF.	COUNTRY	NO. OF PROF.
Australia	- 2	Belgium	- 1	Australia	- 4
Canada	- 438	Canada	- 148	Belgium	- 1
China (Peoples Rep)	- 1	Germany (Fed. Rep.)	- 1	Canada	- 143
Germany (Fed. Rep.)	- 2	Germany (East)	- 2	France	- 3
Germany (East)	- 1	Hungary	- 2	Germany (Fed. Rep.)	- 6
Hungary	- 3	India	- 1	Germany (East)	- 2
India	- 2	Iran	- 1	Greece	- 1
Netherlands	- 1	Ireland	- 1	India	- 3
Poland	- 1	Netherlands	- 7	Japan	- 1
Romania	- 1	Poland	- 1	Netherlands	- 10
South Africa	- 2	Sweden	- 2	New Zealand	- 2
United Kingdom	- 24	Turkey	- 2	Poland	- 1
United States	- 10	United Kingdom	- 11	South Africa	- 1
Yugoslavia	- 1	United States	- 29	Sweden	- 1
		U.S.S.R.	- 3	Switzerland	- 2
				United Kingdom	- 65
				United States	- 115
				U.S.S.R.	- 2
DEGREE TOTAL	489		212		363

TOTAL PROFESSIONALS - 1064

TABLE 17

Highest degree - number of years working in the Department since graduation - number of professionals associated with scientific activities;

BACHELOR		MASTER		DOCTORATE	
NO. OF YEARS IN DEPT.	NO. OF PROF.	NO. OF YEARS IN DEPT.	NO. OF PROF.	NO. OF YEARS IN DEPT.	NO. OF PROF.
0	29	0	12	0	13
1	54	1	32	1	49
2	46	2	27	2	29
3	25	3	23	3	33
4	17	4	12	4	18
5	8	5	7	5	14
6	8	6	13	6	20
7	17	7	11	7	16
8	19	8	8	8	17
9	15	9	6	9	14
10	16	10	9	10	12
11	9	11	6	11	8
12	12	12	5	12	6
13	13	13	3	13	9
14	21	14	2	14	9
15	13	15	2	15	17
16	22	16	7	16	11
17	11	17	8	17	5
18	18	18	7	18	11
19	24	19	3	19	8
20	23	20	4	20	12
21	15	22	3	21	6
22	16	26	1	22	5
23	13	38	1	23	5
24	5			25	4
26	3			26	3
27	4			28	1
28	1			30	1
30	3			31	1
32	3			32	4
33	2			35	1
37	2			39	1
38	2				
41	1				
DEGREE TOTAL	489		212		363

TOTAL PROFESSIONALS - 1064

TABLE 18

Highest degree - number of years working since graduation - number of professionals associated with scientific activities;

BACHELOR		MASTER		DOCTORATE	
YRS. WRNG. SINCE GRAD.	NO. OF PROF.	YRS. WRNG. SINCE GRAD.	NO. OF PROF.	YRS. WRNG. SINCE GRAD.	NO. OF PROF.
0	16	0	5	0	2
1	28	1	11	1	16
2	25	2	20	2	24
3	23	3	13	3	18
4	16	4	16	4	16
5	3	5	5	5	18
6	7	6	10	6	24
7	16	7	9	7	15
8	13	8	5	8	15
9	10	9	9	9	5
10	13	10	5	10	17
11	11	11	8	11	9
12	8	12	4	12	10
13	8	13	2	13	18
14	12	14	5	14	15
15	16	15	8	15	12
16	31	16	6	16	13
17	16	17	15	17	16
18	30	18	8	18	15
19	37	19	7	19	7
20	26	20	8	20	10
21	12	21	6	21	7
22	10	22	2	22	7
23	11	23	1	23	6
24	5	24	1	25	13
25	9	25	7	26	1
26	6	26	1	27	2
27	11	27	2	28	6
28	8	28	3	29	2
29	3	29	2	30	2
30	8	30	2	31	2
31	7	33	1	32	2
32	5	34	1	33	1
33	5	35	2	34	5
34	8	37	1	35	2
35	4	38	1	36	2
37	2			37	1
38	3			39	2
39	3			41	1
40	2			42	1
41	1			44	2
45	1			45	1
DEGREE TOTAL	489		212		363

TOTAL PROFESSIONALS = 1064

TABLE 19

Highest degree - average age;

BACHELOR		MASTER		DOCTORATE	
AGE	NO. OF PROF.	AGE	NO. OF PROF.	AGE	NO. OF PROF.
69	1	68	2	69	1
68	2	65	1	68	1
65	2	64	1	67	1
64	1	63	1	65	1
63	1	60	1	64	1
62	4	59	2	63	4
61	4	58	3	62	2
60	5	57	2	61	3
59	6	56	1	60	2
58	6	55	2	59	1
57	6	54	2	58	3
56	10	53	3	57	3
55	11	52	6	56	4
54	10	51	3	55	7
53	10	50	7	54	6
52	18	49	4	53	4
51	8	48	6	52	6
50	11	47	7	51	7
49	12	46	7	50	5
48	17	45	6	49	3
47	19	44	6	48	9
46	15	43	5	47	8
45	17	42	7	46	9
44	24	41	4	45	18
43	14	40	6	44	10
42	17	39	8	43	19
41	18	38	1	42	11
40	13	37	7	41	12
39	8	36	6	40	16
38	21	35	5	39	10
37	12	34	3	38	17
36	6	33	8	37	10
35	3	32	6	36	15
34	11	31	9	35	11
33	9	30	8	34	14
32	14	29	15	33	10
31	8	28	9	32	33
30	6	27	11	31	14
29	8	26	12	30	9
28	17	25	7	29	23
27	16	24	1	28	6
26	12	23	1	27	6
25	17			26	5
24	18			25	3
23	9				
22	8				
21	2				
20	1				
19	1				
DEGREE TOTAL -	489		212		363
AVERAGE AGE -	40,9		38.7		40.2

TOTAL PROFESSIONALS 1064

TABLE 20

Percentage of professional staff associated with scientific activities able to operate effectively in English and French, by highest degree.

1. Percentages of employees who speak, read and write English and French:

	Bachelors	Masters	Doctors	All
English only	51.0%	42.0%	22.0%	40.0%
French only	0.2	0.0	0.0	0.1
Both	14.2	7.6	17.6	13.5

2. Percentages of employees able to operate effectively in French:

	Bachelors	Masters	Doctors	All
Speak, read and write	14.2%	7.6%	17.6%	13.5%
Speak and read, only	2.2	4.7	5.5	3.8
Write and read, only	7.5	3.8	6.9	6.5
Speak, only	0.2	0.9	0.0	0.3
Read, only	24.0	41.0	48.0	35.8
Write, only	0.4	0.0	0.0	0.2

3. All employees, except one, are able to speak, read and write English.

TABLE 21

Number of professionals associated with scientific activities who, since graduation have been employed by industry, provincial governments or other federal agencies, by universities, or who have been supervised students.

	ACTIVITY	NO. OF PEOPLE EMPLOYED
(A)	University Teaching	225
(B)	Part time university teaching since employment with federal government	127
(C)	Supervision of graduate work since employment with federal government	149
(D)	Employed by provincial government	116
(E)	Employed by private industry	363
(F)	Employed by foreign government	86
(G)	Employed by International agency	21
(H)	Employed by Canadian agency other than present department	168
(I)	Other	71

TABLE 22

Expenditures associated with scientific activities ($000's)

Functions	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
(1) Intramural R&D	14,241	15,204	17,620	23,612	28,274	33,777	40,555
% of Total (Dept.)	28.1	32.2	33.9	28.4	31.0	33.5	36.8
(2) Data Collection	15,239	10,587	11,323	15,720	20,494	26,318	29,864
% of Total (Dept.)	30.2	22.5	21.8	19.0	22.6	26.0	27.1
(3) Scientific Information	3,513	3,936	4,821	5,767	6,105	7,047	8,341
% of Total (Dept.)	6.9	8.3	9.3	6.9	6.7	7.0	7.6
(4) Testing & Standard	267	280	304	926	1,008	1,307	2,088
% of Total (Dept.)	0.5	0.6	0.6	1.1	1.1	1.3	1.9
(5) Support-R&D-Industry	267	280	305	357	368	417	515
% of Total (Dept.)	0.5	0.6	0.6	0.4	0.4	0.4	0.5
(6) Support-R&D-Univ.	126	257	436	703	1,048	1,472	1,600
% of Total (Dept.)	0.2	0.5	0.8	0.8	1.1	1.4	1.5
TOTAL (Functions)	33,653	30,544	34,809	47,085	57,297	70,338	82,963
TOTAL (Department)	50,677	47,179	51,986	83,015	91,084	101,277	110,226

TABLE 23

Scientific discipline	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
(1) Engineering & Technology	4,133	4,409	4,896	6,666	7,204	9,414	12,662
(2) Natural Sciences:							
Agricultural Sciences	-	-	-	-	-	10	42
Astronomy	1,169	1,205	1,433	2,439	2,689	2,718	2,639
Atmospheric Sciences	283	335	444	516	549	397	-
Biological Sciences	128	133	143	209	214	282	354
Chemistry	638	665	716	1,135	1,404	2,441	3,234
Mathematics	-	-	-	-	-	-	42
Oceanography	11,514	7,364	9,514	12,612	17,624	23,808	25,489
Physics	696	726	802	1,067	1,126	1,204	1,290
Solid Earth Sciences	14,723	15,341	16,447	21,788	25,757	29,000	33,961
(3) Social Sciences:							
Demography	25	27	37	47	55	57	-
Economics	344	339	377	606	675	1,007	3,250
TOTAL	33,653	30,544	34,809	47,085	57,297	70,338	82,963

TABLE 24

Areas of Application

	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Nuclear Energy	229	235	274	440	492	532	525
Space Travel & Comm.	187	193	229	390	432	435	422
War and Defence	2,393	1,595	2,033	2,642	3,580	4,423	4,542
Agriculture (incl. fisheries & forestry)	4,047	2,637	3,355	4,298	6,043	7,691	7,901
Construction	549	348	451	578	806	1,013	1,039
Transportation	1,875	1,276	1,624	2,220	2,917	3,563	3,590
Telecommunications	187	193	229	390	432	435	422
Industry	14,209	14,570	15,907	19,077	22,129	23,111	26,077
Econ. & fiscal policy	106	104	113	126	149	244	260
Regional Development	3,797	3,121	3,513	3,933	5,557	6,221	8,790
Other:							
Development and management of Resources	5,607	5,790	6,507	7,428	7,736	8,656	9,660
Development of:							
Water Resources	-	-	-	4,587	5,944	12,926	18,429
Energy Resources	-	-	-	-	-	-	250
Astronomy & Geophysics	467	482	574	976	1,080	1,088	1,056
TOTAL	33,653	30,544	34,809	47,085	57,297	70,338	82,963

TABLE 25

Water and Coordination of Renewable Resources Programs (Sector)

Total budget and expenditures associated with intramural research and development ($000's)

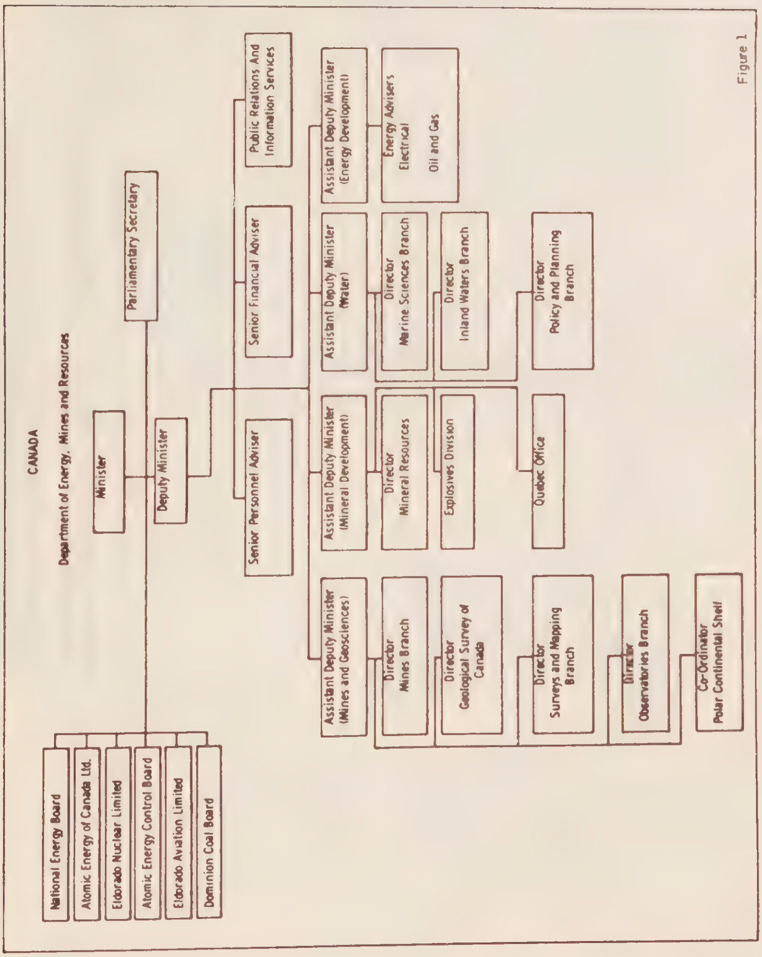
	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Sector Total*	11,325	7,208	9,389	26,029	32,001	42,189	49,838
% of Total (Dept.)	22.3	15.3	18.1	31.3	35.1	41.6	44.0
Sector Intramural R&D*	1,150	1,248	2,492	4,921	6,883	11,995	16,244
% of Total (Sector)	10.1	17.3	26.5	18.9	21.5	28.4	32.6

* Includes pro-rata share of Dept'l Admin. expenditures

TABLE 26

Operating and capital funds expended by Units responsible for scientific activities ($000's)

		1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Mineral Resources Br.	O.	422	415	453	502	594	975	1,015
	C.	2	-	-	2	-	-	-
Energy Development	O	-	-	-	-	-	-	300
	C.	-	-	-	-	-	-	-
Surveys & Mapping Br.	O.	6,464	6,511	6,367	7,609	8,272	9,320	11,097
	C.	209	168	223	417	453	752	901
Geol. Surv. of Can.	O.	5,772	6,300	6,491	6,898	7,255	8,585	9,926
	C.	379	265	364	751	2,349	631	980
Mines Branch	O.	4,682	4,800	5,160	5,806	6,188	6,850	7,563
	C.	401	455	468	817	562	638	1,007
Observatories Br.	O.	1,816	1,928	2,018	2,385	2,607	3,219	3,807
	C.	520	482	848	2,473	2,770	2,164	1,422
Polar Cont. Shelf Proj.	O.	1,435	1,382	1,411	1,281	1,782	1,585	1,822
	C.	175	139	68	71	117	34	216
Marine Sciences Br.	O.	5,388	6,032	6,862	8,066	9,055	11,555	15,110
	C.	5,602	932	2,152	3,496	7,069	8,705	5,671
Inland Waters Br.	O	-	-	-	3,662	4,447	7,237	11,250
	C.	-	-	-	625	1,059	4,522	5,528
Policy & Planning Br.	O	-	-	-	94	254	401	4,045
	C.	-	-	-	-	-	-	3


CANADA
Department of Energy, Mines and Resources
Minister
Parliamentary Secretary
Deputy Minister
National Energy Board
Atomic Energy of Canada Ltd.
Eldorado Nuclear Limited
Atomic Energy Control Board
Eldorado Aviation Limited
Dominion Coal Board
Senior Personnel Adviser
Senior Financial Adviser
Public Relations And Information Services
Assistant Deputy Minister (Mines and Geosciences)
Director Mines Branch
Director Geological Survey of Canada
Director Surveys and Mapping Branch
Director Observatories Branch
Co-Ordinator Polar Continental Shelf
Assistant Deputy Minister (Mineral Development)
Director Mineral Resources
Explosives Division
Quebec Office
Assistant Deputy Minister (Water)
Director Marine Sciences Branch
Director Inland Waters Branch
Director Policy and Planning Branch
Assistant Deputy Minister (Energy Development)
Energy Advisers
Electrical
Oil and Gas
Figure 1

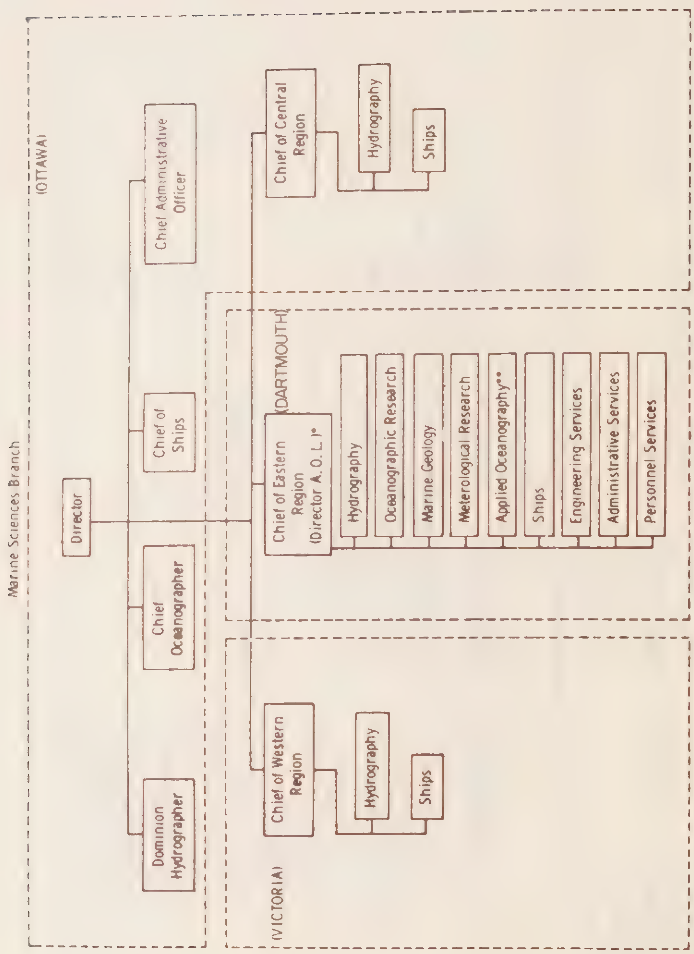


Figure 2

* Atlantic Oceanographic Laboratory, which is part of the Bedford Institute of Oceanography. (The other part is the Marine Ecology Laboratory (M.E.L.) of the Fisheries Research Board)

** The Applied Oceanography Section includes personnel from both A.O.L. and M.E.L., and undertakes projects on behalf of both laboratories. These projects are funded by the initiating body, although personnel and equipment are used wherever required.

GEOLOGICAL SURVEY OF CANADA

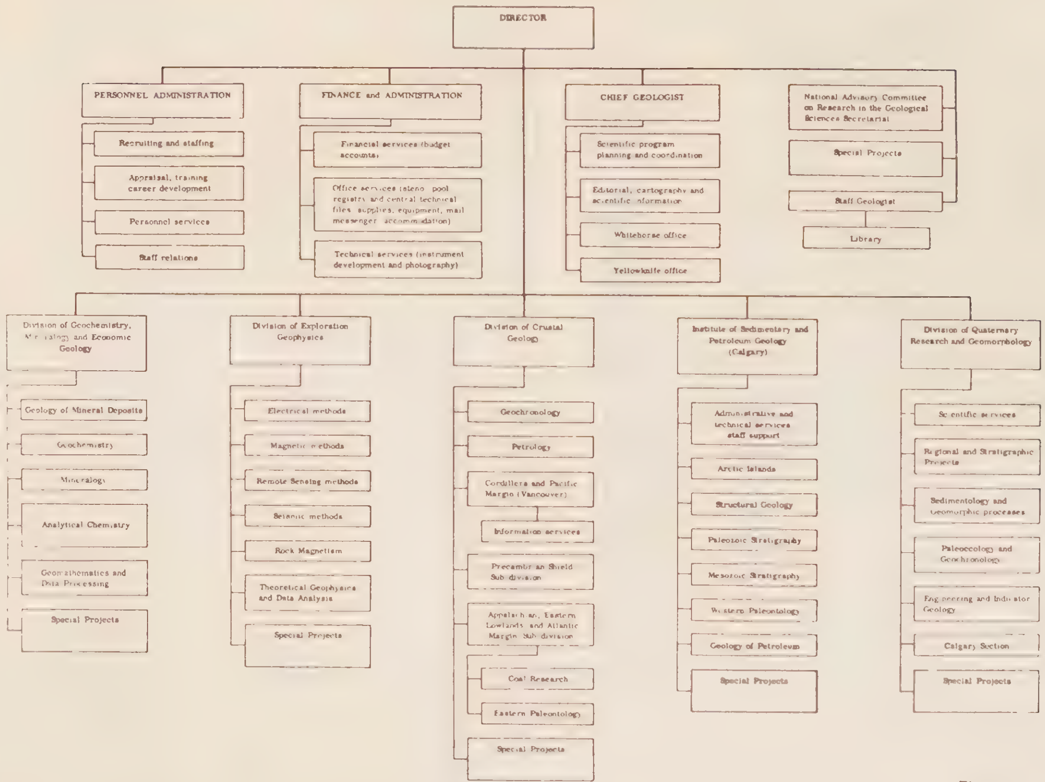


Figure 3

August 196-

First Session—Twenty-eighth Parliament
1968

THE SENATE OF CANADA

PROCEEDINGS OF THE SPECIAL COMMITTEE ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*

The Honourable DONALD CAMERON, *Vice-Chairman*

No. 17

THURSDAY, DECEMBER 12th, 1968

WITNESSES:

Department of Fisheries and Forestry: Dr. A. W. H. Needler, Deputy Minister; L. S. Bradbury, Director, Industrial Development Service.

Fisheries Research Board: Dr. F. Ronald Hayes, Chairman; Dr. W. Robert Martin, Assistant Chairman; Dr. Henri A. Favre, Member.

APPENDICES:

15.—Statement by Dr. A. W. H. Needler, Deputy Minister, Department of Fisheries and Forestry.

16.—Brief submitted by the Department of Fisheries, Part I: Introduction.

17.—Brief submitted by the Department of Fisheries, Part II: Fisheries Research Board of Canada.

18.—Brief submitted by the Department of Fisheries, Part III: Department of Fisheries of Canada.

THE QUEEN'S PRINTER, OTTAWA, 1969

29613—1

MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird	Hays	O'Leary (*Carleton*)
Belisle	Kinnear	Phillips (*Prince*)
Bourget	Lamontagne	Robichaud
Cameron	Lang	Sullivan
Desruisseaux	Leonard	Thompson
Grosart	MacKenzie	Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—

The question being put on the motion, it was—

Resolved in the affirmative."

29613—1½

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

THURSDAY, December 12th, 1968.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 10.00 a.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Belisle, Bourget, Grosart, Kinnear, MacKenzie and Robichaud. (7)

Present but not of the Committee: The Honourable Senators Carter, Kinley and McGrand. (3)

In attendance: Philip Pocock, Director of Research (Physical Science).

The following witnesses were heard:

DEPARTMENT OF FISHERIES AND FORESTRY:

Dr. A. W. H. Needler, Deputy Minister;
L. S. Bradbury, Director, Industrial Development Service.

FISHERIES RESEARCH BOARD:

Dr. F. Ronald Hayes, Chairman;
Dr. W. Robert Martin, Assistant Chairman;
Dr. Henri A. Favre, Member.

(*A curriculum vitae of each witness follows these Minutes*)

At 12.25 p.m. the Committee adjourned until 3.30 p.m. this day.

AFTERNOON SITTING

The Committe resumed at 3.30 p.m., the Chairman, Senator Lamontagne, presiding.

Present: The Honourable Senators Lamontagne (*Chairman*), Belisle, Bourget, Grosart, Kinnear, Lang, Leonard, MacKenzie, Robichaud and Yuzyk. (10)

In attendance: Philip Pocock, Director of Research (Physical Science).

The witnesses at the morning sitting were further questioned.

The following is printed as appendices:

15.—Statement by Dr. A. W. H. Needler, Deputy Minister, Department of Fisheries and Forestry.

16.—Brief submitted by the Deparement of Fisheries, Part I: Introduction.

17.—Brief submitted by the Department of Fisheries, Part II: Fisheries Research Board of Canada.

18.—Brief submitted by the Department of Fisheries, Part III: Department of Fisheries of Canada.

At 5.25 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Needler, A. W. H. Born in August, 1906, at Huntsville, Ontario. Son of George Henry Needler, former Professor of German at University of Toronto. Educated at University of Toronto Schools. Married 1st, Alfreda Alice (died 1951), daughter of C. J. Berkeley, Nanaimo, B.C., May 30, 1930; Three children: Mary, George, Edith; 2ndly, Nina M. Parker, March 20, 1953; Two children: Duncan, David. B.A. from University of Toronto, 1926. M.A. from University of Toronto, 1927. Ph.D. from University of Toronto, 1930. D.Sc. (Hon.) from University of New Brunswick, 1954. Volunteer investigator, then full-time biologist, with Fisheries Research Board in P.E.I., 1924-1929. Scientific Assistant, Fisheries Research Board, 1929-1930. Assistant Zoologist, Fisheries Research Board, 1931-1937. Associate Zoologist, Fisheries Research Board, 1937-1939. Chief Zoologist, Fisheries Research Board, 1939-1941. Director, Atlantic Biological Station, 1941-1954. Concurrently Assistant Deputy Minister, Fisheries, 1948-1950. Director, Biological Station, Nanaimo, 1954-1963. Deputy Minister, Fisheries, 1963-1968. Deputy Minister, Fisheries and Forestry, 1968. He was a member of the Committee on Fisheries Statistics, North American Council on Fisheries Investigations, 1928-1939; and Adviser to the International Passamaquoddy Fisheries Commission, 1931-1934. In 1945 he was Secretary to the Fisheries Committee, 1st FAO Conference at Quebec, and member of the Canadian delegation, 2nd FAO Conference, Copenhagen, 1946; and was Scientific Alternate Chairman, Atlantic Herring Investigation Committee, 1944-1950. He was a delegate to the Northwest Atlantic Fisheries Conference, Washington, 1949, and first Chairman of the resulting Committee on Research and Statistics, International Commission for Northwest Atlantic Fisheries, 1951-1954. He was Federal Government member, P.E.I. Fisheries Development Committee, 1951-1955; appointed Chairman, FAO Advisory Committee on Marine Resources in 1963, also appointed Chairman, International North Pacific Fisheries Commission in 1963. In 1966, he was elected Chairman, FAO's new Committee on Fisheries. His work has covered many areas of fisheries research, such as oceanography, haddock ecology, life history and migration, fisheries statistics biological study, Atlantic oyster ecology; and has directed research on salmon, groundfish, herring and other potentially important fish of the Pacific Ocean. He was made an officer, Order of the British Empire, in recognition of his work in fisheries during World War II; and is a Fellow of the Royal Society of Canada.

Bradbury, L. S. Born June 12, 1913, at Bay Roberts, Newfoundland. Educated in St. John's, Newfoundland and Boston, Mass. Married to Margaret Brophy; four children, William, Jean, Paula and Robert. From 1936 to 1949 held responsible positions with the Newfoundland Fisheries Board in connection with the Newfoundland and Labrador fisheries. He was Newfoundland trade representative in the West Indies for seven years while he was serving with the Board, and was stationed in Jamaica and Puerto Rico. In 1949, after the union of Newfoundland with Canada, he became Director of Newfoundland Fisheries at Ottawa for the federal Department of Fisheries, serving in that capacity until 1952 when he was appointed the Department's Area Director in

Newfoundland. In February 1955 he was appointed Director of the Department's Industrial Development Service in Ottawa, his present post. In 1952 he was made Chairman of the Newfoundland Fisheries Board, and after the Board became an agency of the Department of Trade and Commerce, he continued in that office until 1959, when the Newfoundland Fisheries Board Act was repealed by the Parliament of Canada. In 1936 he was the Newfoundland Government appointee to the Co-operative Extension Course of St. Francis Xavier University, Antigonish, N.S. From 1953 to 1955 he was a Canadian Commissioner on the International Commission for the Northwest Atlantic Fisheries (ICNAF). He has also served as a member of the Newfoundland Fisheries Loan Board. In 1966-67 Mr. Bradbury was a Canadian member of the Fisheries Committee of the Food and Agriculture Organization of the United Nations, Rome. He is chairman of the Interdepartmental Committee on Fisheries Development, the Industrial Development Section of the Federal-Provincial Atlantic Fisheries Committee, and of its Conference Co-ordinating Committee. He is also a member of the Federal Interdepartmental Committee for the Newfoundland Household Resettlement Program.

Hayes, F. Ronald: Chairman, Fisheries Research Board of Canada. Born at Parrsboro, Nova Scotia, April 29, 1904. Education: Halifax Academy and Pictou Academy; B.Sc., Biology, Dalhousie University, 1926; M.Sc., Biology, Dalhousie University, 1927; Ph.D., Oceanography, University of Liverpool, 1929; Rockefeller Foundation Post Doctoral Fellow, University of Kiel, 1929-30; D.Sc., University of Liverpool, 1948; Hon. Li.D., Dalhousie University, 1964; Hon. D.Sc., Memorial University of Newfoundland, 1964. Appointments: Dalhousie University, Associate Professor of Zoology, 1930-48; Professor of Zoology, 1949-59; Director, Institute of Oceanography and Chairman of the Division of Biological Sciences, 1959-64; Vice-President, Dalhousie University, 1963-64; Chairman, Fisheries Research Board of Canada since 1964. Scientific and Professional Societies: Fellow, Royal Society of Canada, 1946; Chairman, Animal Biology Section, Royal Society of Canada, 1963; Member, Fisheries Research Board of Canada, 1955-64; Member, National Research Council of Canada, 1959-64; President, American Society of Limnology and Oceanography, 1968. Publications: Approximately 50 publications in scientific journals in the field of marine biology.

Martin, W. Robert: Assistant Chairman, Fisheries Research Board of Canada. Born in Toronto, Ontario November 25, 1916. Education: B.A., Zoology, University of Toronto, 1938; M.A., Zoology, University of Toronto, 1939; Ph.D., Ichthyology, University of Michigan, 1948. Military Service: RCAF Clinical Investigation Unit 1941-45. Appointments: Scientist-in-charge, Groundfish Investigations, Fisheries Research Board of Canada, Biological Station, St. Andrews, N.B., 1945-63; First Executive Secretary, International Commission for the Northwest Atlantic Fisheries, 1951-52; Assistant Chairman, Fisheries Research Board of Canada since 1963. Professional and Scientific Societies: Member, Canadian Society of Zoologists, American Fisheries Society, American Institute of Fishery Research Biologists. Publications: Approximately 40 papers in ichthyology and fisheries biology.

Favre, Henri A.: Professor of Chemistry, University of Montreal. Borne at Payerne, Switzerland December 4, 1926. Education: Primary and secondary schools in Payerne and Fribourg, Switzerland; Ing. Chem. Dipl., Swiss Federal Institute of Technology, 1948; D.Sc. Tech., Swiss Federal Institute of Technology, Zurich, 1951; British Council Post Doctoral Fellow, University of Sheffield, 1951-52. Appointments: Assistant Professor, Dept. of Chemistry, University of Montreal, 1952-57; Associate Professor, Dept. of Chemistry, University of Montreal, 1957-60; Professor, Dept. of Chemistry, University of Montreal since 1960; Director, Dept. of Chemistry, University of Montreal, 1959-63; Dean and Director of Studies, Faculty of Science, University of Montreal, 1964-68. Scientific and Professional Societies: Chemical Institute of Canada, Division of Organic Chemistry, Secretary, 1954; President, 1955: Chemical Institute of Canada, National Counsellor, 1957-60; Director of Student Affairs, 1959-62: Member, Fisheries Research Board of Canada since 1965: Member, The Chemical Society, England: Fellow of the Chemical Institute of Canada. Publications: Approximately 20 publications in scientific journals in the field of organic chemistry.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

MORNING SITTING
(First Session)

Ottawa, Thursday, December 12, 1968

The Special Committee on Science Policy met this day at 10 a.m.

Senator Maurice Lamontagne (Chairman) in the Chair.

The Chairman: There is a slight change in the program this morning, and one which I think will be more convenient to the members of the committee. We had intended to hear the Fisheries Research Board this morning, and the Department of Fisheries this afternoon, but since they both work together so closely, Senator Robichaud suggested that we hear them at the one time. They will make two opening statements, and then we shall have a general discussion with the two agencies. This, I think, will be more useful, and will provide for a more orderly discussion.

So, I am pleased to welcome again this morning Dr. Needler, the Deputy Minister, who was with us yesterday as the Deputy Minister of Forestry.

On his right is Mr. W. C. MacKenzie, Director of Economic Service. On my left is Dr. Hayes, Chairman of the Fisheries Research Board, and next to him is Dr. Martin, the Assistant Chairman. At the end is Dr. Favre, a member of the board and also Professor of Chemistry at the University of Montreal.

With that introduction I understand that Dr. Needler will commence by making a brief opening statement.

Dr. A. W. H. Needler, Deputy Minister, Fisheries and Forestry: Mr. Chairman, I would not like to take up the time of the committee needlessly, and I think we have distributed an introductory statement which is applicable to the whole Fisheries ministry covering the activities of both the Fisheries Research Board and all other services. We have a fairly large volume which covers the activities of the Fisheries Research Board, and, naturally, it is the largest because the Fisheries Research Board is the organization which carries out fisheries research. We have another smaller submission which describes some of the scientific activities of other branches of the department. As this general introduction has already been tabled I would not like to waste your time by reading it. You have doubtless read it already.

I should like to point out one or two general features. The Ministry of Fisheries in addition to research, which is an important part of its activities, has the responsibility for the administration of the fisheries because the basic fisheries jurisdiction in Canada is federal. This contrasts with forestry, for example, where the basic jurisdiction is provincial.

Originally, of course, the very first objective that was given the department at the time of Confederation more than one hundred years ago was the protection of the resource, so we have the objective of maintaining the yield of fish, and the fish stocks. Fish, incidentally, under the Fisheries Act includes things that are not fish, such as lobsters, oysters, and whales. None of these things are fish to a biologist, but they are the object of fisheries. We have as an objective increasing these yields by various artificial means. We also have the objective of increasing the efficiency of the industry, to develop, demonstrate and introduce new fishing methods to attempt to bring new fish stocks into use; in other words, to have the fishing industry make the best possible use of the resource.

We have another general field of responsibility which has to do with the fish processing industry and the control of quality, because under the Fish Inspection Act it is our responsibility to inspect fish exported from Canada and imported into Canada, which enter into interprovincial trade.

In all of these activities we must have close contact and co-operation with industry, and in some of them with the provinces also. Indeed, in some cases the responsibility for certain of these functions, especially for the maintenance of the resource, has been delegated to the provinces. This is true of certain inland fisheries such as purely fresh water fisheries of provinces like Ontario. Nevertheless, all these activities take place under the federal Fisheries Act, but even in this case I suppose the federal government department has the ultimate responsibility for seeing that the job is properly done.

All these basic objectives and purposes of the Ministry of Fisheries require a scientific basis. It must be quite obvious that the conservation of the resource, fish culture, or resource development as we call it now, the maintenance of quality, improvement of processing methods and improvement of fishery methods, now require a scientific basis. The research to provide this scientific basis is carried out by the Fisheries Research Board, and you will shortly hear from Dr. Hayes, chairman of the board. There are also some activities of a scientific nature associated with the application of the results of the basic research, and we consequently have some scientific activities associated with fish culture, assessment and remedies, abatement of pollution. The processing industry inspection of fish products even requires some technical scientific work, and some of the exploratory matters, such as the development of new fishing methods, and so forth, also have a very close relation to research and scientific activities.

A feature which is perhaps not highly developed but is perhaps a more important feature in fisheries than almost any other of our activities, is the international aspect. Fisheries are not merely a common property resource within the country, but fisheries of the oceans are common property resources outside of territorial waters in areas of special interest. In order to conserve such fisheries it is necessary to enter into many international agreements and have discussions and negotiations with other countries. There have been a number of international bodies, usually called commissions, set up to arrange as far as possible for international action to maintain the yield from international fisheries. This also requires a great deal of scientific input from all the countries concerned, so that there are some scientific activities in the various services of the Department of Fisheries as distinct from the Fisheries Research Board.

In general, one might say that the department's scientific activities are really based on the research carried on by the board.

Mr. Chairman, I do not think I need take up any more of your time now. I understand that this document which has been distributed is part of your committee's record.

The Chairman: Yes, this is part of the proceedings. Thank you very much, Dr. Needler. We will now hear from Dr. Hayes.

Dr. F. Ronald Hayes, Chairman, Fisheries Research Board: As Dr. Needler said, the Fisheries Research Board, about which I will speak, is the agency within the ministry responsible for scientific research and its activities are complemented, as was also noted by Dr. Needler, by several development programs within the department. In fact, today the line between research and development is becoming increasingly blurred.

Board Origin and Organization

2. The Fisheries Research Board of Canada is the oldest Government-supported scientific board in North America. Since its creation in 1898 it has been known by several titles and received its present name by act of Parliament in 1937. From small beginnings, and pursuant to several amendments to the act, it has broadened in scope and undergone changes in organization.

3. In its present form the board consists of a full-time chairman and up to 18 honorary members appointed by the minister for five-year terms, of whom at present ten are university scientists, seven are individuals selected from the fishing industry and one is an appointee from the Department of Fisheries.

A week ago we sent out the annual report of the board, which was tabled some time before that in Parliament. In the front of this annual report there are listed the members of the Fisheries Research Board in 1967. There have been some changes. For example, Mr. Eriksen from Prince Rupert has been replaced by Captain Pallant from Prince Rupert. Mr. Guy LeBlanc from Quebec industry has been replaced by Mr. Blais from Quebec, and Mr. Russell from St. John's, Newfoundland, another industry member, has been replaced by Mr. Pratt, also from St. John's.

The list is otherwise substantially correct and it indicates that there is regional representation of industry members. For example, from the east coast there is Mr. Corney of Acadia Fisheries Ltd. and Guy LeBlanc whose name I mentioned in connection with the replacement in Quebec; Hazen Russell from the Bonavista Cold Storage Company, St. John's, Newfoundland and W. L. Williamson of Conley's Lobsters Ltd., St. Andrews, New Brunswick. Thus the industry has some direct input into the research policies of the department and we consider that this combined industry and university representation should keep the board on the practical track and form a very good balance.

The Chairman: Before you go on could you tell me if you are the only full time member?

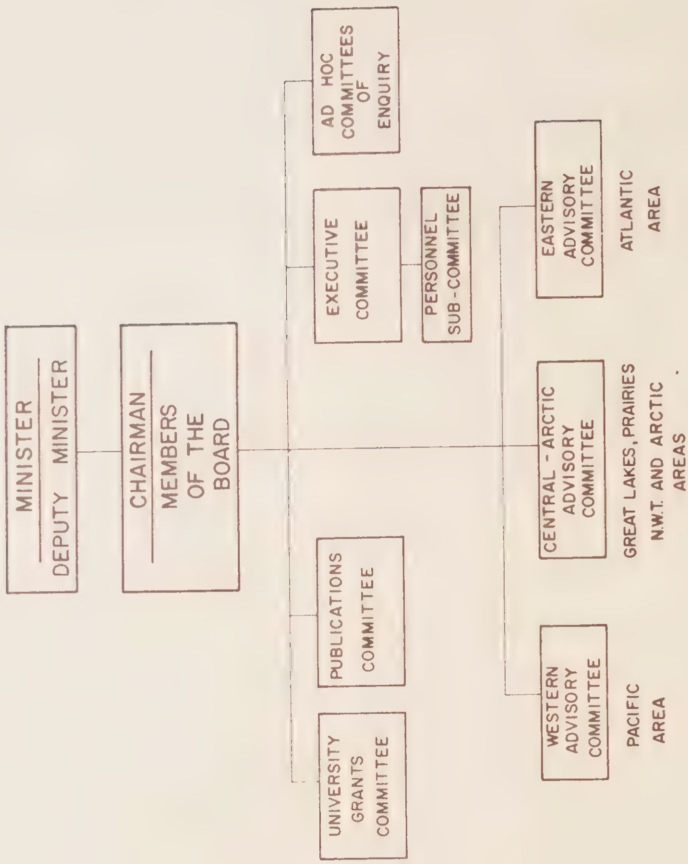
Dr. Hayes: I am the only full time member. The other members of the board are honorary members.

The Chairman: What about the assistant chairman?

Dr. Hayes: The assistant chairman sits at board meetings, but is not a member of the board according to the act. Also the deputy minister—by tradition I think, since it is not in the act—sits at board meetings and with the executive of the board when it meets.

4. The membership of the board is divided into three regional advisory committees—eastern, Central-Arctic and western—which meet once or twice annually with directors of FBR establishments and regional directors of the department to review proposals and budgets and to adjudicate regional priorities.

At this point I will place on record a chart of the organization of the Fisheries Research Board of Canada.


MINISTER
DEPUTY MINISTER
CHAIRMAN
MEMBERS OF THE BOARD
AD HOC COMMITTEES OF ENQUIRY
EXECUTIVE COMMITTEE
PERSONNEL SUB-COMMITTEE
PUBLICATIONS COMMITTEE
UNIVERSITY GRANTS COMMITTEE
EASTERN ADVISORY COMMITTEE
ATLANTIC AREA
CENTRAL - ARCTIC ADVISORY COMMITTEE
GREAT LAKES, PRAIRIES N.W.T. AND ARCTIC AREAS
WESTERN ADVISORY COMMITTEE
PACIFIC AREA

5. An executive committee, consisting of representatives of the regional advisory committees with the chairman and the deputy minister acting *ex officio* members, establishes national priorities.

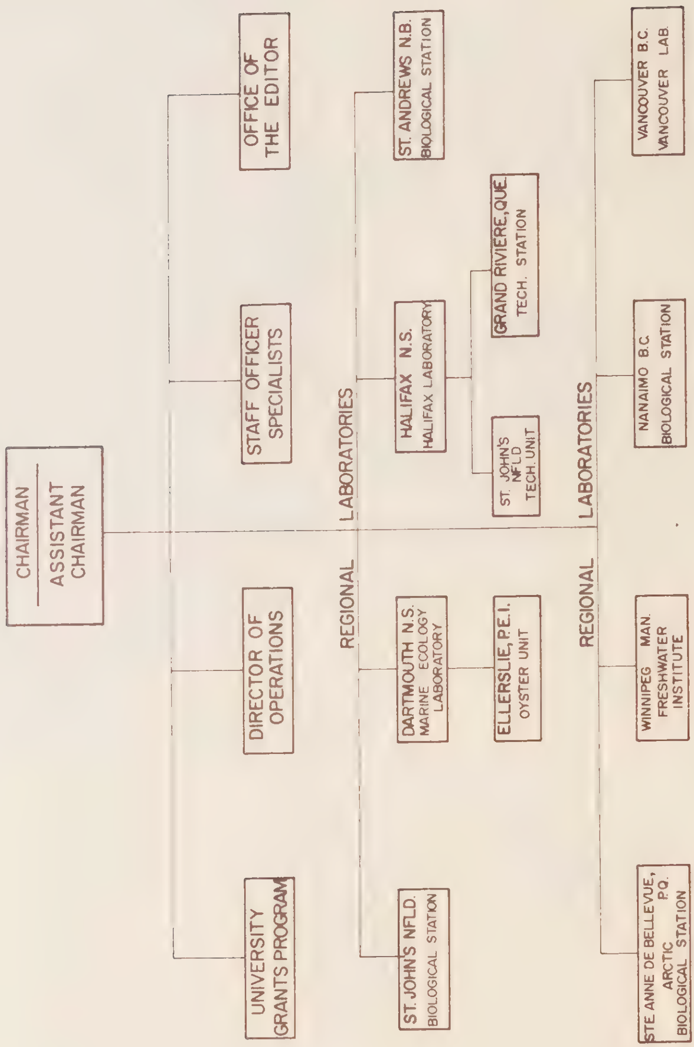
6. The full Board, at its annual meeting, receives reports from its committees and develops national policies. National policy recommendations for government action are submitted to the Minister of Fisheries through the deputy minister. Recommendations not constituting change in national policy are handled through the chairman to the directors of the board's research establishments.

Research Establishments

7. The board is unusual among comparable agencies in not having laboratories in Ottawa. The Ottawa staff of the office of the chairman has been kept small, with substantial authority and accountability delegated to laboratory directors. Decentralization is considered essential for a proper research environment which, in turn, detemines whether the FRB can attract and hold good scientists. In large measure the regional distribution of the board's research establishments is determined by their proximity to major fisheries and/or water resource areas. Regions particularly suited to research activities are those which are in close contact with the fishing industry and preferably near academic institutions and the department's regional offices.

8. Using 1967 as a sample year, 40 per cent, of the board's operating expenditures were made by five laboratories in the Atlantic Provinces (St. John's, Nfld.; Dartmouth, N.S.; Halifax, N.S.; St. Andrews, N.B. and Grande-Rivière, P.Q.) Research activities in the Arctic (based at Ste. Anne de Bellevue, P.Q.) and in the Great Lakes, Prairie Provinces and N.W.T. (based at Winnipeg) accounted for 17 per cent of the expenditures. Two laboratories on the west coast (Nanaimo and Vancouver, B.C.) accounted for 33 per cent. Expenditures in Ottawa, including the offices of the chairman and editor and the university support program made up the balance of 10 per cent of our expenditures.

At this point I should like to place on the record a second chart. This is taken from our longer report and gives the distribution of FRB establishments across the country.


CHAIRMAN
ASSISTANT CHAIRMAN
OFFICE OF THE EDITOR
STAFF OFFICER SPECIALISTS
DIRECTOR OF OPERATIONS
UNIVERSITY GRANTS PROGRAM
REGIONAL LABORATORIES
ST. ANDREWS N.B. BIOLOGICAL STATION
HALIFAX N.S. HALIFAX LABORATORY
GRAND RIVIERE, QUE. TECH. STATION
ST. JOHN'S NFLD TECH. UNIT
DARTMOUTH N.S. MARINE ECOLOGY LABORATORY
ELLERSLIE, P.E.I. OYSTER UNIT
ST. JOHN'S NFLD. BIOLOGICAL STATION
REGIONAL LABORATORIES
VANCOUVER B.C. VANCOUVER LAB.
NANAIMO B.C. BIOLOGICAL STATION
WINNIPEG MAN. FRESHWATER INSTITUTE
STE ANNE DE BELLEVUE, P.Q. ARCTIC BIOLOGICAL STATION

9. As mentioned by the deputy minister in his opening remarks, the sea is a common property resource; hence individual Canadians have no adequate incentive to invest in the husbandry of its wealth and potential. For this reason, and because of the fragmented nature of the industry, there is no real alternative to government sponsorship of fisheries research. Industry participation is limited to some product and equipment work by the larger companies, and trials with new or modified gear by occasional enterprising fishermen. The development services of the Department of Fisheries assist with applications of research. Universities do some basic research which varies according to location and staff interests. Provinces and international commissions deal with certain species (e.g. trout in most inland waters, Pacific halibut, two species of Fraser River salmon). However, the Fisheries Research Board has unique responsibilities, in developing research in the broad field of fisheries in Canada, which have been assigned by Act of Parliament.

10. With its relatively small population, Canada cannot afford to emulate the United States or the Soviet Union in lavish support for all branches of science. Canada's resources in men and money, its geography and its needs, all force it to concentrate on outstanding achievement in specialied fields. In keeping with this, the Fisheries Research Board has focused its attention on particular areas of scientific research.

I would like to say, sir, that our future with respect to research and government research looks, as I have noted, somewhat different from that in most industrial work in which there is some reasonable hope that industries can take the bulk of the research effort from the Government. There is no expectation that research on populations of fish on the high seas will ever be handled by individual industries since they will never control the waters, and the results of their research could be used by any one in the world in international waters or by any Canadian in Canadian waters. Besides fisheries we have responsibility to some other clients.

Clients

11. Some scientific boards, like defence, presumably exist solely to serve their ministries. Others, like the Medical Research Council, are totally separated. The major part of the FRB budget is for the direct use of the fisheries ministry but its fairly wide outside connections also warrant mention.

12. Ministry of Fisheries. Sixteen for more nations fish the western north atlantic and at least four fish the eastern north pacific. To provide management and conservation there have been several treaties under which international commissions have been set up. The FRB provides research and scientific advice to Canadian delegations for most of these bodies. Within Canadian waters the conservation regulations for such forms as lobsters, oysters, herring and salmon are based partly on information supplied by FRB research. In fact FRB research plays a role, directly or indirectly, in the management of all marine commercial fisheries in Canada as well as sport fisheries in the Atlantic region. Much useful information is in turn derived by FRB scientists from observations on management practices of the Department of Fisheries.

In the present state of fisheries we acknowledge any regulation which is passed by the Department of Fisheries, in a sense as an experiment which is worth observing as a research enterprise to see what results it will produce.

Formal agreements regarding activities between the board and other organizations usually develop from commitments made in the national interest by the ministry in the course of international negotiations, or during federal-provincial discussions. The board participates, in varying degrees, by provision of scientific advice and/or data to commissions created by six multi-nation conventions, five conventions between Canada and the United States alone and to one of the special working committees of the Food and Agriculture Organization of the United Nations.

13. The Fishing Industry. Since 1924 industry representatives have been active members of the FRB. Concurrently laboratories were established for the development, in close collaboration with industry, of improvements in the preservation and processing of fish, and of new products from fish. The biological search for new stocks of fish to be exploited, and for means of increasing stocks of lobsters, salmon, etc., is also of direct use to industry.

14. Other Federal Agencies. The board has important formal connections with at least eight other federal agencies. These associations encourage exchange of information on subjects of mutual concern and the provision of such advice to other departments as the FRB is qualified to give. Formal associations

exist with the Departments of National Defence, Indian Affairs and Northern Development, Health and Welfare, Agriculture, Forestry and Rural Development, External Affairs, Transport, and Energy, Mines and Resources. In respect to the last-mentioned department, that is, the Department of Energy, Mines and Resources, the Prime Minister designated, in 1966, the Minister of DEM & R to "take a leading role in formulating and coordinating programs concerning water in Canada." DEM & R proposes a Canada Water Act which is to provide coordinating machinery at federal and federal-provincial levels. Meanwhile, (1967), the cabinet has authorized an interim committee which, with its several sub-committees, is coordinating the work of federal agencies. The principal topic is water pollution control for which the best enforcement legislation is the Fisheries Act and in which the Department of Fisheries and the board have been active for many years, within the limitations of their budget allotments. The Ministry of Fisheries took the lead in the committee in presenting an adequate, integrated, inter-departmental program of anti-pollution research and pollution control suited to the Canadian economy, public desires and government policy.

15. Universities. The FRB has on occasion made its ships, laboratories and field stations available for research by qualified academics. It also operates a modest grant program designed to assist certain university departments to improve the opportunities for graduate students to undertake theses in aquatic science. This policy regarding university support, though still in its early stages of development, has the particular aim of producing much needed recruitment of trained personnel with a bias towards renewable aquatic resources. It is important that universities be equipped to provide the necessary graduate training for the interdisciplinary needs of FRB, and that students be encouraged to accept the challenge presented by fisheries research. The policy of the Board to strengthen its relationship to universities has a number of purposes: to increase the supply of high quality graduate students oriented towards FRB activities and make them aware of the material and intellectual possibilities of employment by the board; to increase within the universities active research in fields of interest to the board; to gain intellectual stimulus arising out of specialist consultation; and to encourage direct cooperation on research projects between board and university staff or graduate students.

16. The Provinces. West of New Brunswick and south of the Territories the stocks of fish in inland waters are provincially managed, but FRB has always done considerable freshwater research on basic problems that are applicable to management. The provinces do virtually no product research.

17. Responsibilities: According to the Fisheries Research Board Act. "The board has charge of all Dominion fishery research stations in Canada, and has the conduct and control of investigations of practical and economic problems connected with marine and fresh water fisheries, flora and fauna, and such other work as may be assigned to it by the Minister."

18. The Canadian Government has a responsibility to know all that can be known about the total Canadian environment. This includes the vast Canadian bodies of fresh and salt water. These waters are unique to Canada, and while knowledge gained elsewhere may be useful on occasion, it can never be a substitute for detailed understanding of our own aquatic environments and the life therein. According to the act, the federal Government originally delegated primary responsibility in these matters to the Fisheries Research Board of Canada. From time to time new agencies have been created to deal with special problems. Where responsibilities overlap the FRB may participate in the new research or, to avoid duplication, its existing activities may be coordinated as required.

19. It is not enough to be charged with responsibilities; it is also necessary to discharge these responsibilities through the best available means. The deployment by the FRB of limited resources has in the past brought notable returns in specific areas where definite problems in aquatic resources demanded solutions. In large part these problems and successes resulted from the rapid change in the fisheries of Canada from fairly primitive harvesting operations to vertically integrated food industries. A relatively few talented scientists have thus brought the FRB to a position commanding respect from its international peers.

20. As an interdisciplinary organization the FRB unites experience and motivation in diverse sciences for the study of water

resources. This approach is well illustrated by our knowledge that there are many alterations in microscopic aquatic organisms which subtly reflect deterioration in water quality. The cumulative expression of these alterations is readily recognized as "pollution", but at this late stage not only are valuable freshwater fisheries lost but the water itself may be lost as a social and economic resource. The few lonely complaints of a few years ago concerning loss and destruction of our freshwater resources have become a chorus of bitter recriminations. Action must be taken, but the economic implications of comprehensive pollution control are so staggering that any proceedings must have a sound scientific basis. The fusion of available talents in physics, chemistry and biology will enable FRB scientists to make substantial contributions, based on sound scientific principles, to a better understanding of water pollution and the effects of measures necessary for pollution control.

21. The FRB's activities used to be grouped in classical divisions of science, such as chemistry, biology, oceanography. The FRB's present activities range over a wide area, both scientifically and geographically. Scientifically they may be broadly defined under five categories: The environment, the resource, increasing the resource, harvesting and management, and commercial products. Few fields of research are covered in sufficient depth to have as great an impact on the fishing industry, or in this area of science, as would be desirable.

Future Requirements

22. The view of the fishing industry regarding fisheries research, as expressed through the Fisheries Council of Canada in 1967, is that research should be expanded, and that this should be done by the FRB with the cooperation of the Department of Fisheries, of provincial governments, and through stimulation of fundamental research at universities.

23. It is likewise the view of the board that the research activities which have been mentioned must be broadened and increased if Canada is to exploit its renewable common-property aquatic resources effectively. Some areas require special attention during the years immediately ahead, with a corresponding large increase in staff and facilities:

(a) The special talents of FRB must be given the opportunity and scope for development in respect to biological aspects of the urgent interdepartmental assault on freshwater and marine pollution.

(b) In the face of ever increasing competition from foreign nations, it is vital that studies be expanded to develop utilization of poorly understood resources and reduce the cost of fishing for those resources which are already well utilized, particularly those over which Canada can maintain her sovereignty.

(c) Work should increase to assure solution of vexing problems which continue to stand in the way of effective positive measures to increase the supply of our most valuable species such as lobsters, oysters and salmon.

(d) Again in response to mounting international competition, more research must be directed to the study of fish behaviour to provide a sound biological basis for development of new apparatus, techniques and tactics to increase the efficiency of our fishing industry.

(e) Likewise, increasing competition at the international market place calls for increased work on the improvement of quality of existing products, and the development of new products from the great variety of organisms and biological materials available in the aquatic environment.

24. In viewing these requirements, particularly respecting antipollution research, the base of the board's responsibilities must be broadened—beyond the sole consideration of fish and fisheries—to include a large and active share in the responsibilities for water resources generally.

25. Closer collaboration with universities is essential, not only to assure the continued supply of talented recruits to fisheries research but also to encourage active participation by universities in studies fundamental to the understanding of fishes and their responses to their environment.

26. To meet the expanded requirements and broadened base of fisheries research, the board foresees the need to increase "wet" laboratory facilities, experimental tanks, etc. and also to build up a fleet of modern research vessels to conduct FRB work and to supply the needs of university scientists.

27. It is asserted that if we are to meet these expanded responsibilities, annual expenditures must be doubled or trebled during the next decade. With an enlarged budget we would still expect, as at present, to limit our efforts to uniquely Canadian fields where outstanding achievements for Canada are most likely to emerge.

Thank you, sir.

The Chairman: Thank you, Dr. Hayes. Some of you around this table will undoubtedly recognize the member of the committee who will initiate the discussion this morning. Senator Robichaud.

Senator Robichaud: Thank you, Mr. Chairman. First, may I join with you in welcoming the Deputy Minister of Fisheries, Dr. Needler, and members of his department, as well as Dr. Hayes, the Chairman of the Fisheries Research Board and the representatives of that board. I am also very thankful to you, Mr. Chairman, for having agreed to amend our agenda so that we could have before us together the department and the Fisheries Research Board. I would say that we are fortunate in having as deputy minister of the department Dr. Needler who, as you will note from his *curriculum vitae,* has spent 40 of his 48 years of service with the Fisheries Research Board. Incidentally, I might point out that in the late 1930s and early 1940s I happened to serve on Fisheries Commissions with Dr. Needler.

It is also important to note the close relation between the department and the board. I recall when I was an employee of the department in the middle 1930s, when I was employed as a fisheries officer responsible for conservation and protection measures, that 75 per cent at least of my activities were with members of the Fisheries Research Board. So it shows that for many years there has always been a very close relation between the board and the department.

Before I proceed with some detailed questions, I would ask Dr. Hayes, who has mentioned that the board also consists of representatives of the fishing industry, which as he has stated is of some advantage to the board, how often do the board members meet?

Dr. Hayes: There is an annual meeting of the board required under our act which takes place usually in the first half of January. That is the only occasion, which is necessitated legally when the full board meets. In addition to that, the regional advisory committees meet once or twice a year. They usually meet at one or other of our laboratories or somewhere where an installation is being set up or an experiment is being carried out. For example, Professor Favre's committee met last June at Heming Lake, in northern Manitoba, where we have had experiments going for some years.

At meetings of this sort they examine the work of the station and at the same time the directors from the station involved meet with them and have a general discussion of their problems. So the advisory committee will usually meet twice a year and the full board once in addition to special consultations from time to time.

Senator Robichaud: The board having such close relations with the department, could you elaborate and tell us how you determine your policy or how you select specific projects? Are they influenced by the department, are they done at the request of the department or the ministry or are they initiated altogether within the board itself?

Dr. Hayes: No, sir. They may come from various sources. I would say that most of the projects which are adopted by an advisory committee will reach them from the directors of the laboratories who invariably have more things to propose than there is budget to accommodate. These are screened initially by the advisory committee. In addition, we have recommendations from the other agencies of the ministry coming in and we may have requests from agencies of government outside the ministry, federal or provincial. Something may come as a result of international commitments between Canada and the United States to set up research, and we are then instructed as a research agency to carry out work, let us say, on the distribution of some species of Pacific salmon on which there is some debate going on with the United States, with Russia, or with Japan regarding fisheries.

From all these varieties of input of suggestions, the advisory committee makes its selection and these selections and priorities go then to the executive committee of the board which again has to prune them to the budget and which makes a final selection on a national basis.

Senator Robichaud: You have mentioned the budget. Remarks or statements have been made at different times to the effect that the

amount of money spent by the Department of Fisheries or by the Fisheries Research Board in relation to the value of Canadian fisheries is relatively high. For example, the landed value of Canadian fisheries is approximately $150 million a year for a commercial value of $300 million. Would you comment on this statement?

Dr. Hayes: I think we have considerably wider responsibilities than fisheries. If you try to consider such a problem as the national sovereignty on the continental shelf, for example, in which Canada must show its activity and dominant activity, you will see that our responsibilities are considerably wider. We must be the people out there with the ships and with the crews conducting the investigations on the floor of the sea with its animal populations from our side, while others are concerned with the mineral resources, and so on.

We are also concerned with pollution, and will be more heavily concerned. This is not a Fisheries problem, but we have connections with other government departments such as Northern Affairs and we are invited to report on the capacity of the lakes to support, for example, a population of Eskimos in certain areas of the country. Canada's responsibility for developing the north in which we participate is not calculable in terms of fish returns, and so I think the board has very much broader responsibilities than can be calculated by a simple formula regarding the landed value of fish.

Dr. Needler: Mr. Chairman, may I add a point on this? I think the $300 million level of commercial fisheries value which Senator Robichaud mentioned is true enough, but I think also there is another value which is very difficult to assess but which is growing very rapidly, and that is the recreational value of fish, and many of these stocks with which the department is concerned are very important in that field. It is quite possible that 25 years from now these values may support more people than commercial fisheries in some areas. This is another important responsibility we have because we are responsible for stocks from this point of view as well as from the point of view of commercial fishing.

The Chairman: I know some of the salmon in the lower St. Lawrence and in the Gaspé area are very expensive—to certain fishermen.

Senator Robichaud: I have one question respecting personnel. I understand that the Fisheries Research Board is considered, and this was mentioned yesterday by another departmental official who appeared before us, as an "exempt establishment," if I can use that expression; in other words, that the scientists are not selected through the normal channels of the public service commission. Can you tell us if there is any advantage to this procedure, and if you recommend this system?

Dr. Hayes: I think historically in Canada the board council type of management such as we have in the National Research Council and the Defence Research Board has had a greater level of flexibility, and also I think somewhat greater financial rewards for the scientists employed than has been the case for those agencies which were part of the public service. We have prided ourselves that not only for our scientists but also for our technical assistants we have operated on the merit plan rather than on the job rating plan. I believe the general tendency of pressure in the public service is to evaluate a job and say "This is a janitor of a small building, and that job is worth so much, and the only way to get more is to become a janitor of a larger building and transfer." But we know that in evaluating scientists you have to say "If this man is good, then we pay him what he is worth." We presume he is doing good scientific work and we apply this principle to our technical and support staff as well as the higher grades of research scientists. The job rating value plan is probably all right in Ottawa in which there is a large group among which a man can move, but with dispersed laboratories such as we have, if we have a man in Nanaimo and we say "You can get him a better job as long as he moves to New Brunswick" this is not a very flexible system. I believe that as regards the higher grades of scientists of Ph.D. calibre and above, beginning this year, 1968, the public service is introducing conditions of labour which compare quite favourably with those of the boards. But I don't know that they are applying this merit principle yet to support staff. But if they catch up with the boards probably one can look for a diminution in the advantage, at least I certainly hope so. As a Canadian I would like to see the whole public service scientific group come up to the conditions which are enjoyed by the board council type of scientist. So far we have been better off.

The Chairman: But in addition to the financial advantages, do you find that operating on a board system you have more flexibility, and also in hiring people and making exchanges within universities and industry?

Dr. Hayes: I wonder if I could ask Professor Favre to comment on the board system in its broader aspects.

Dr. Henri A. Favre, Member, Fisheries Research Board, and Professor of Chemistry, University of Montreal: It is very difficult to answer because I think it is a matter of efficiency. When the board was established very little research was carried out in Canada, and then it was, I think, quite necessary to have an independent system and a very strong participation from people really acquainted with resource problems and resource management. I would say that, like Dr. Hayes, I do not see the purpose of keeping these things going on, because I think research now is becoming a real national enterprise and an endeavour. I think all scientists should be on the same footing. Therefore I would not say it is necessary for the board as long as we have the guarantee that the mechanism will keep these people happy and productive. As I said it is really a matter of efficiency.

Senator Robichaud: I have a related question to Dr. Needler concerning the department. On page 6 of Part III of the submission of the Ministry of Fisheries there is a portion which reads as follows:

> The department's competitive position might be strengthened if prospective recruits, or perhaps more properly, the most promising ones, could be assured of sound career growth patterns. Moreover, the services of some highly qualified personnel might be retained if the department were given reasonable latitude to pay its scientific personnel according to their worth.

Could you give us some specific examples, Dr. Needler, where the department has had problems? I understand that in some research branches of the department, the Industrial Branch, for example, such problems have existed.

Dr. Needler: Well, Mr. Chairman, I find it difficult to give detailed examples. In general at the moment we are trying to improve the academic background and the, shall we say, technical or scientific competence of research in a number of our services. This is true in inspections where we want to have a higher proportion of the people with some bacteriological training, for example. This is true in our need to have biologists, capable biologists, in the application of results of research to fish culture techniques. I know that in the latter case it has sometimes been difficult to get what appeared to us to be comparable salaries to scientists in the academic world or scientists employed by other government agencies such as the research board itself. There seems to have been a tendency to regard the applied scientist as a sort of lower animal as compared with the research scientist, whereas I think it could be stated that in Canada research is in better shape than the application of science in the applied science field.

To my mind, although I was the Fisheries Research Board Director for over 20 years, I think it requires extremely able people to apply scientific results in such matters as fish culture and so forth; and although their abilities are different, their abilities may need to be just as great as those of research scientists, and it is in these cases that we find, in discussing salary levels, it is rather difficult for us to pay the good people to get them into these fields. We have discrepancies. For example, at the moment people with comparable responsibilities in biology—I suppose I might be biased, I am a biologist—but people with comparable responsibilities and academic qualifications are paid less than engineers and doctors. Engineering and medicine seem to be fields where the application of science has paid very well, but applied biologists seem to be sometimes classified as rather lower grade, and I do not think this is good for the country. This is really what we have in mind.

Senator Bourget: Who decides that? Is it the Civil Service?

Dr. Needler: I think it is a combination of the Public Service Commission and the Bureau of Classification Revision of the Treasury Board. But I feel very strongly that if we are going to make good use of science we have to pay the people who can translate research results into valuable activities about as much as we pay the research people. Otherwise we will only get the dregs, and this is the field that is weakest at the present time.

Senator Robichaud: I only have two more questions, Mr. Chairman, and then I feel I should leave the field free to my colleagues who, I am sure, have many questions to ask.

The first one is on pollution, referred to in both briefs, the one from the department and the one from the board. Could you tell us, Dr. Hayes, how long the Fisheries Research Board has been concerned with pollution, and also give us some details as to what lines of investigation are currently being pursued?

Dr. Hayes: Yes, sir. I believe our first paper on the subject of pollution was published by a man who was then chairman of our board, Dr. A. P. Knight, in 1901, and we have been publishing research articles in this field ever since, so we have quite a history.

Our area of concern is in the division of responsibilities among several federal departments and it is with living materials in the water, including bacteria which decompose the bottom sediments, nuisance growths of algae which cannot be disposed of and cause unpleasant smells in water which is of recreational interest as well as that of fish.

As Dr. Needler mentioned in his introduction, the only federal legislation, outside of navigable waters, which can be used to prevent pollution is concerned with the fitness of the water for fishes, and we are working on the general line of thinking that if water is fit for fishes it is probably pretty good water for recreational purposes generally.

Undoubtedly, if this sort of matter comes into legal disputes in the courts, there will be questions on how much of various substances can be tolerated and on what level they can be considered to be pollutants; and we have a responsibility I think, in a general way to define the level of pollution for various classes of substances which are deleterious to fish—for example, oil refinery effluents or pulp mill effluents. There is a certain level which could be argued by lawyers in the courts, if one had evidence. We have a responsibility to know what is happening to living organisms as a result of this.

We would also like to develop some way of getting rid of these growths of algae. These are terminal growths. Most of the plants developed get eaten up and come into the metabolic system of a lake and get into end growths, like blue-green algae which are nuisance growths.

There are, broadly speaking, two kinds of pollution. One, the introduction of poisons which may be heavy metals from zinc or iron mills, mine tailings, and so on, on the one hand, or maybe DDT kinds of insecticides. The other kind is over-fertility of the lakes, and over-fertility does not necessarily destroy the fish population but usually knocks out the game fish in favour of fish which up to the present have not been so highly preferred in Canada.

This process of enrichment by nutrients where there is a dense population around, as in the Great Lakes, is very imperfectly understood, and I think we have the responsibility of understanding this process of the enrichment of lakes and of bringing it under control. It is often things like phosphates and nitrates, where population surrounds a body of water.

Senator Robichaud: My last question is to Dr. Needler. Again, with regards to pollution, you have mentioned that the department has certain authority, under the Fisheries Act to take action. Has the department been active in this field? Is action being taken regarding the construction of pulp mills or mining developments on streams or rivers frequented by fish? Has the department taken any definite action in this regard?

Dr. Needler: Well, Mr. Chairman, the department, of course, does not want to get into court actions more often than necessary—

Senator Robichaud: What about preventive action?

Dr. Needler: —and, indeed, the legislation is such that the department finds it rather difficult to prevent pollution. In other words, the federal government's permission is not required to introduce effluents. But industrial establishments or, indeed, any other that can be shown to have introduction pollution which damages fisheries, are subject to certain penalties. Sometimes there have been prosecutions of this kind but, in general, we try to work with the industry. This requires some effort in making the necessary contacts. Indeed, it requires, in some degree, a good bit of co-operation with other agencies. We try to discuss plans at a very early stage.

I would say that the pulp industry in the western part of Canada, for example, has made progress in this respect. It is usual now for anybody who proposes to build a pulp mill to discuss waste disposal with the department and with the experts in the field, and to provide, often at considerable expense,

means of taking care of waste so that it will not damage the fish. We consider that this has been done in at least two pulp mills on the Fraser River, which is an important river, and we hope it will be done by every pulp mill that establishes itself on that river. So, we are able in this way to prevent pollution at times. Actually, we would be in a better position if we had a little more preventive authority. I think this would be desirable.

Senator Kinley: I should like to ask about the phenomenon on the Great Lakes with respect to salt water fish such as salmon and smelt, which are increasing so rapidly. In the United States there are many people who are interested in fishing...

Senator MacKenzie: You are talking about the cohoe in Lake Michigan? Is there anything in this story, or is it a fish story?

Dr. Needler: It is a fish story, but it is true. The State of Michigan introduced cohoe into the Great Lakes by planting eggs in the streams, and having the eggs hatch and go down to the lakes. The fish grew very rapidly and survived very well, partly because there is an excessive population of things called alewives which provide good food for them. Everybody hailed this as a very good thing because it might solve the nuisance problem of the alewives, as well as providing a big sports fishery. I think this might still be true, although I understand there is some doubt as to the effectiveness of the reproduction of these fish in the next generation. However, that is not certain yet.

There may be considerable difficulty in providing large cohoe populations with suitable conditions for reproducing themselves in that area, but I am not saying that this is not going to take place. It is at too early a stage to know whether there is a big self-sustaining population.

Senator Kinley: Have you any scientific thinking as to why a salt water fish that goes into the rivers to spawn and then goes back to sea can live in the waters of the lakes? It might be very cold water. Of course, the smelt increase very rapidly, and now the salmon are living off the smelt. That is one reason why they are growing so fast. Do you think the pollution of the lakes has anything to do with their growth?

Dr. Needler: Mr. Chairman, as Dr. Hayes said, pollution is fertilization in its early stages– at least, one kind of pollution is—but it is not at all unusual for any of the fish in this general group of salmon, trout, smelt, and so forth to thrive in fresh water. There are, as I think most people are aware, landlocked Atlantic salmon that live their whole life through in fresh water, and the same is true of the sockeye salmon on the Pacific coast. As we know, there are smelts, which are mainly salt water fish, that spawn in fresh water, and also thrive in fresh water. Some of the trout go to sea, and some do not. So, in this particular group of fish it is pretty common for the adults to be able to live and thrive in fresh water. I would not think this would be true of some other groups.

Senator Kinley: How do you account for the fact that the largest fish we have live in the Arctic waters? I am thinking of the whale, the trout and the Arctic char, which I think is a kind of trout. It seems to me that the fact that they grow there under such peculiar conditions is something we should know about.

Dr. Needler: Mr. Chairman, I do not think there is any close correlation between ultimate size and latitude. Although there are large whales in the Antarctic as well as the Arctic, there are also large whales throughout other parts of the world, and there are also large fish of different kinds throughout the world, such as the tuna and the shark, which are tropical fish. So, I doubt the generalization. I would not think there is any correlation between size and latitude.

Senator Bourget: There are less fishermen out there, I suppose.

Senator Kinley: We have the biggest fish there too, such as the halibut and the whale. It is surprising to see the productivity of the sea in the north in those very cold waters. When you get down to the tropics you do not get such good fish. It seems that they need cold water. It is now said that the salmon is being exploited by Denmark off Greenland; that they have found that they concentrate there, and they have taken huge quantities. Is that true?

Dr. Needler: I think they have been taking some Atlantic salmon off Greenland, but I would not characterize the amounts as huge quantities. They have taken, shall we say, seriously large quantities from our point of view, but these are not really Arctic waters. They are not very cold waters at the time the salmon are here. They are not Arctic waters.

Senator Kinley: And then shrimp was always supposed to be a warm water fish, but they have become abundant in northern waters. What do you say about that?

Dr. Needler: Shrimp, Mr. Chairman, have always been abundant in northern waters. They are different species in different areas. The Gulf of Mexico shrimp which we get on our markets...

Senator Kinley: Are they better shrimp?

Dr. Needler: I would think that the northern shrimp that appear in our waters and Norwegian waters, which are the same species, are definitely superior to any others.

Senator Kinley: I just want to say something about pollution. Dr. Hayes said that we have been quite late in recognizing this problem of pollution. I think the fishmeal business has been a great factor in preventing pollution by the fishermen themselves. When they were cleaning fish they used to discard the waste in the waters over the pier head. The fishmeal business has been not only a great help to the fishing industry, but it is a great help in preventing pollution of that kind. What do you say about that, Dr. Hayes?

Dr. Hayes: I am sure that the best method of preventing pollution is the prevention of things going into the water. By throwing in bits of unused fish is certainly a way to get this kind of additional fertilizer to the water. This is one of the troubles in the Great Lakes. They have been over-fertilized. As you say, in certain harbours where fish waste has gone overboard, a quite unpleasant situation can be alleviated by grinding up the whole fish into meal. Yes, this is true.

Senator Carter: Looking through the brief, I see that on page 2 you refer to the five laboratories in the Atlantic provinces, including St. John's. There is no mention of the laboratory established at Valleyfield. Can you tell me what happened to that? Is it operating now, has it been leased out, or what?

Dr. Needler: Perhaps I could ask Mr. Bradbury to answer this. It was not really a scientific laboratory. It was an experimental salt fish curing plant. Mr. Bradbury is Director of our Industrial Development Service.

Mr L. S. Bradbury, Director, Industrial Development Service, Department of Fisheries: This was known as a fish processing experimental plant established at Valleyfield in Newfoundland about 13 or 14 years ago. It was established at the time in order to carry out experimental work in the processing of mainly salted cod fish. However, other activity was eventually undertaken at this plant. In the department we eventually reached the time when we had found all the answers to problems posed to us by the salt cod fish industry, so there was really no further need for this plant. In other words, we did not consider that it should any longer be a charge on the taxpayer, and for this reason it was leased to commercial interests about three years ago.

Senator Carter: Was it never under the auspices of the Fisheries Research Board?

Dr. Needler: No.

Mr. Bradbury: As in other activities, we did have the full co-operation of the Fisheries Research Board technological stations.

Senator Grosart: Like Senator Carter, I do not like to eat and run, but I do have a commitment elsewhere. I should like to put this question to Dr. Hayes. I sense throughout your statement, and occasionally in the larger submission, some doubt whether the 1966 decision that the Minister of Energy, Mines and Resources "take a leading role in formulating and co-ordinating programs concerning water in Canada" was a wise decision. You say elsewhere that the best enforcement legislation is in the Fisheries Act, and you make similar comments at other places. Are you satisfied that this is working out well, having the leading responsibility with the Minister of Energy, Mines and Resources in this area?

Dr. Hayes: This is asking a public servant to comment on government policy. We accept governmnt policy and undertake to make it work. We are co-operating effectively, according to the policies of the Government, with the agencies which have been designated to do certain jobs.

Senator Grosart: You say on page 5:

> The Ministry of Fisheries took the lead—in presenting an adequate, integrated, inter-departmental program of anti-pollution research and pollution control suited to the Canadian economy, public desires and Government policy.

What happened to that?

Dr. Hayes: The co-ordinating authority is the Ministry of Energy, Mines and Resources. I think what was meant by "taking the lead" was that the Ministry of Fisheries presented its brief and program before either of the other major federal departments, namely the Department of National Health and Welfare and the Department of Energy, Mines and Resources. The Ministry of Fisheries brief then went in, and eventually was joined by other similar ministry proposals, in the field of health from the Department of National Health and Welfare, and from the Department of Energy, Mines and Resources in the fields of chemicals, geology and the physical side of pollution control. These are being put together in a major national proposal. Since it is the Great Lakes, there is also a high interest level from the Province of Ontario. This provincial concern is also taken into the consolidated report, which will include all the efforts of all the ministries and also the economic and sociological aspects as well as the scientific ones. We put in a ministry proposal in which the research activities of the Fisheries Research Board would be combined with the control and development activities of the resources development agencies for the country. That is what has happened to it.

Senator Grosart: In this committee I am sure we are all looking for exactly what you have described here, a "program of anti-pollution research and pollution control," which in your words is "adequate, integrated and inter-departmental." Does such a thing exist? Is this an entity? Is it a dream?

Dr. Hayes: No, there is something having some resemblance to the Fisheries Research Board that has been sponsored by the Department of Energy, Mines and Resources, consisting of representatives of the federal agencies concerned, of Ontario, and some university representatives to look into pollution research. There are also some economists, because it is not only the scientific side but the economic aspects, and they are interested in research. I am not sure whether it has gone to the Treasury Board yet, but there is either in preparation or possibly prepared a document which incorporates our ministry proposal, which is referred to there, with other ministry proposals to make this integrated document. I do not know what the status of it is now. Perhaps Dr. Martin does.

Dr. W. Robert Martin, Assistant Chairman, Fisheries Research Board: It is in a final stage of preparation and I think we can look forward to seeing the final document within the next two or three months.

The Chairman: Before the decision was taken in 1966, could you describe the interest that the Department of Energy, Mines and Resources had in water, oceanography, I presume, and possibly also hydrology?

Dr. Hayes: For very many years the Department of Energy, Mines and Resources was concerned with hydrographic services, tidal predictions, maps and charts. Up to a dozen years or so ago the Fisheries Research Board had responsibility for oceanographic research in Canada and this blew up during the war in relation to the needs of the Navy and we had a heavy commitment for meeting the needs of defence as well as fisheries and a general division was made at that time under which the physical oceanographic defence needs would be transferred to the Department of Energy, Mines and Resources and that would be concerned with biological matters. We have a joint interest in the environment since populations of fish in their migrations and distribution are related to the boundaries of water masses and also the detection of submarines as relevant to the boundaries of water masses and we have a joint investigation with the Department of Energy, Mines and Resources in this area on the Atlantic coast and the responsibilities have been taken over pretty well by that department. On the Pacific coast the Fisheries Research Board is still engaged on oceanographic research.

At the time this agreement was made a dozen years ago the Great Lakes pollution problem became a very major national matter and when it did come up the whole question was reconsidered and the division made, concerning the living aspects of pollution research in living materials. The physical end is being cared for by the Department of Energy, Mines and Resources so pollution work and oceanography in fresh water and—

The Chairman: I would like to pursue this.

Senator Grosart: The final part of my question arises from the fact that yesterday I was seeking information on the degree of mechanism and control of co-ordination in this pollution area from the witnesses of the Department of Energy, Mines and Resources. I am surprised that, if my recollection is correct, we had no mention then of the proposed Canada Water Act which Dr. Hayes' submission describes as one proposed by that

department to provide co-ordinating machinery at the federal-provincial level. Can you tell us anything about the Canada Water Act?

Dr. Hayes: It has not been tabled and I do not know whether Dr. Martin can add anything to that statement or Dr. Needler.

Senator Grosart: You say the Department of Energy, Mines and Resources "proposes" this?

Dr. Needler: I think it is may be a little bit wrong for us to discuss a proposal by another department at this stage.

Senator Grosart: It is here in your brief.

The Chairman: It is just referred to.

Senator Grosart: That is enough to start us.

The Chairman: I do not think you will go into orbit. It was a nice try.

Senator Grosart: I defer to your ruling, Mr. Chairman.

Senator Belisle: Thank you very much, Mr. Chairman. I realize that Sudbury is not known as the Honolulu of the United States but is well known as a fishermen's paradise and we do get big ones. We may not get them as big as the species Dr. Needler referred to as whales, but we do enjoy having these facilities to spend our extra nickel. Coming back to a more serious note since fisheries are a common property resource no one can establish property rights; no individual can refer to a fish bank as his. There will be a tendency for a society to invest too much in fishing efforts to get the fisheries available, consequently there will be too much resource invested in fisheries and one might expect that the regulations should attempt to limit the entry in this industry, but if there is such regulation what are the criteria? How are they used?

The Chairman: This is regarding entry into the industry.

Dr. Needler: I think that is quite clear that when you have a common property resource, as long as the exploitation pays, people will keep rushing in on their own accord until it reaches just a very doubtful economic level and barely pays. This has happened in the case of fisheries on which the market has not limited it especially and of course we have not got around to international limitation of entry to fisheries yet, although this is under serious discussion. Some way of limiting the fishing effort has been discussed internationally by a number of international commissions and by the Food and Agriculture Organization in the United Nations, but this has not come to fruition yet.

We introduced just this year a form of limitation of entry into the salmon fishery industry on the Pacific coast in which studies indicate that there are more than twice as many people, equipment, and fishing effort involved as would be needed to harvest the resource fully.

The Chairman: Twice as much.

Dr. Needler: At least twice as much and I think this is similarly true of certain other fisheries.

Senator Robichaud: Lobsters.

Dr. Needler: So we have been taking steps in this direction, but so far the only step that has been taken has been a moratorium on new entry. On the Pacific coast this has been done by having a moratorium on an increase in the number of salmon fishing boats.

Senator MacKenzie: You licence the boats?

Dr. Needler: The boats are registered and licenced and the salmon fishing boats are really in a different class. Those which are rather small participants in the fishery are allowed to remain until these facilities disappear. The others can be replaced. Eventually steps should be taken to reduce these numbers and there are various devices which might be used to do this in a just fashion, although I must say that the various interests involved in different groups of fishermen have different ideas as to what would be the best mechanism. One would be for some agency of the Government to buy up the licences, make an offer to buy licences.

Senator MacKenzie: Is it your department that issues the licences?

Dr. Needler: Yes.

Senator MacKenzie: Therefore you control the number of fish.

Senator Robichaud: Maybe you should give us as an example of control the salmon fisheries on the Atlantic coast where there is real control.

Dr. Needler: We have had strict control of entry into the salmon fishery on the Atlantic coast for urgent conservation reasons and we

have not allowed new licences. This has been licences to fishermen. This, I think, is a problem that will increase in importance because it has been the experience of the world that the larger the population the more fisheries you will have.

The fisheries in the inshore waters of Japan have become extremely extensive; more so than ours. As our population increases the fisheries will become more extensive. Over the decades one fishery after another will reach this stage where it will be necessary if the fishery is to be economic. There is another reason also for the reduction in the number of salmon fishing units, that is, that with an excessive number of fishing units, management becomes very difficult.

Salmon management is based essentially on discovering how many spawners are needed; and this is so regulating the fishery as to let the optimum number of spawners through. This can be done only by a pretty detailed and continuous contact with the fishery, which indicates it is the only way of discovering how strong the runs are and what is happening to them. The number of fishing units in the salmon fishery has become so excessive on the Pacific Coast that there are cases, even with fairly large runs, where in order to let enough spawners through it has only been possible to permit fishing for one or two days a week. And when this happens it increases the difficulty of achieving a good management, which is to let the optimum number of spawners through but on the other hand not to curtail the fishing unnecessarily. If they were fishing for five days a week, this would be much easier to do. So there is a conservation reason and an economic reason for this kind of limitation.

Senator Robichaud: Is it not a fact that on the Atlantic coast, going back to the control of salmon fishing, there is a limited number of licences, and no new entries are permitted in the commercial salmon fishery on the Atlantic coast—unless in the case of replacement?

Dr. Needler: That is true.

The Chairman: If you have succeeded in doing this on the Atlantic coast, why do you find it more difficult to apply it on the Pacific coast? Are there political factors?

Dr. Needler: I think it is difficult on both coasts, but this sort of project is not easy, in the sense that it is very difficult, in these cases, to find some solution that pleases everybody. As a matter of fact, I think it is impossible to find a solution that pleases everybody, you have to have some sort of compromise. The Pacific coast salmon industry is so much bigger that all of the pressures and the differences of opinion are very much better developed. This has been under consideration on the Pacific coast for a good many years. Finally, action was taken this fall. The first step, in other words, a moratorium on new entry. This will have to be followed by some steps which may be rather gradually but effectively leading to some reduction in the number of units.

Senator Belisle: What I say is very complimentary, because I have observed in the last two days that you are a very kind, courteous and careful diplomat. Would you comment on the future of the 80,000 fishermen? I know the minister has expressed a view, at least I read it in the *Globe and Mail*, and he is optimistic about it. Do you feel that way? Should the licences be reduced again?

Dr. Needler: I think that as fishing becomes more efficient, and it is steadily becoming more efficient just as in the case of farming, fewer people will make use of this particular resource. I think that actually the big problem and essentially the reason for not moving too fast is that these people who have made their livelihood in fisheries for generations, some of them, have to be taken care of in one way or another.

As a matter of fact, the Government has made some approaches or some attempts to make it easy for people to move out of a low income occupation in fisheries, to be trained and to move into a better occupation. Especially, in some areas where the educational level is rather low and where the traditional attachment to the area and to the occupation is rather high, this has got to be a slow process, it has to be a process which is slow enough to make this kind of adjustment possible.

Senator Belisle: If this 44-mile limit were set in the mouth of bays, I believe it is not settled, would it give more freedom to our fishermen, or more fishing, do you think?

Dr. Needler: It would reduce the competition to some extent.

Senator Belisle: Is there some invasion—I mean, from outside, within the 12-mile limit?

Dr. Needler: Mr. Chairman, we are getting into a rather complicated subject. At the moment, I would say there is very little serious difficulty in enforcement, from this point of view. People are not entering territorial waters, or our 12-mile limits, illegally, to any great extent. There are a few infractions but these are taken care of. When Canada announced its 12-mile fishing zone it also announced that it would discuss with nations which had customary or historic fisheries within this zone, that it would discuss with those nations such matters as the phasing out periods and so forth and also there has been some discussion regarding claims to bodies of water. I know that Senator Robichaud is listening to this, and it may be he is glad that I am answering. I do not know. Our 12-mile zone was established and by regulation.

Senator MacKenzie: That was done unilaterally, was it not?

Senator Robichaud: Which is an international practice also.

Senator MacKenzie: It applies to some countries, but it has never been ratified by law.

Dr. Needler: There are too many remarks. May I finish? The countries which has historic fisheries were temporarily exempted from the 12-mile limit. They were temporarily allowed by the regulation under the Coastal Fisheries Protection Act to enter these zones as long as these negotiations were continuing. So, they have been there legally during negotiation. On the other hand, the twelve mile zone has been enforced against the new entrants like the USSR and others.

Senator Belisle: Thank you. I gather it would be easier skating if I go back to the brief.

The Chairman: I agree with you.

Senator Belisle: The objectives mentioned explicitly at page 4 seem to be directed to the maintenance and improvement of yields, of fishing effort, to the efficiency of the industry, and to the control of the industry. Since you have singled out the need for regulations, could you elaborate on the reasons which make the regulations of the fisheries necessary? Moreover, what form does this regulatory activity take? Is the purpose to limit the amount of fishing effort, or is it to help anybody entering this industry?

I know that you partly answered this a while ago, but could you elaborate on it?

Dr. Needler: Mr. Chairman, it is rather difficult to generalize because there are a number of reasons for fisheries regulations. One of the purposes of the regulations is to maintain the stocks. Biologists have their jargon just like management consultants, scientists and others, and one of their phrases is "maximum sustainable yield". One of the purposes of the regulations has been to so influence fishing as to produce the maximum yield from the fisheries over a long period.

Initially, this has been done by such measures as regulations preventing people from taking small fish at a time when their growth is at its maximum—that is, when the fish are growing faster than they are dying off—or when their value is low. We have size limits. There have been measures to prevent the taking of fish during periods when they are particularly vulnerable. There have been closed seasons imposed.

Now, there have been other regulations which are really based on economic reasons, and in this respect I can cite some of our lobster regulations which are designed to have people catch lobsters at a time when they are valuable, and to avoid taking them when too many of them have been moulting and their shells are soft, and that sort of thing, or to avoid taking them when they come into competition in our big market in the United States with the peak of the catches in Maine. These regulations are imposed for economic reasons. Historically, these are the two kinds of regulations.

I have mentioned already that in a fishery that is as well understood and as intensive as the Pacific salmon fishery we have a pretty good idea of what the optimum numbers of spawners are, and we regulate to let those through. We have other regulations which we would like to modify, and which have arisen from conflict of interests between groups of fishermen. A fisherman using one kind of gear often does not like fishing with another kind of gear. It is felt that there is some conflict here, and the department has been called upon sometimes to impose regulations to prevent such conflicts. Some of these are, you might say, based on public demand rather than on a firm conservation or economic reason.

Senator Belisle: I have two more questions. At page 5 of Part I you say that the FRB has

the dominant responsibility for the research of the Department of Fisheries. Does this agency have any autonomy to launch any independent research project? If so, is the board, which is composed of 18 members selected from universities, government, and industry, supposed to define the priorities for such research of a more curiosity-oriented nature? Is this, in fact, the case?

Dr. Needler: I am not sure that I understand your question.

Senator Belisle: The question is this: Does this agency have any autonomy to launch any independent research project, apart from any suggested by the universities?

Dr. Needler: Oh, yes.

Senator Robichaud: I believe Dr. Hayes touched on that point.

Dr. Hayes: Yes, we receive information and suggestions from a variety of sources, and these are screened, and the ones that appear to be most in the national interest are accepted and proceeded with. The board, in this sense, orients all of its projects, but it has...

The Chairman: The Department has nothing to do with this?

Dr. Hayes: Ultimately. The board is administering a fraction of the budget, and it carries out such work as it is directed to carry out by the Minister. So, to this extent, the minister directs the board to do something, but, in general, the department's views about the necessities are known, and so are the views of the board's directors and other agencies, and out of this comes the program. But, there is an influence of various—I should say, in terms of physics, that the activities of the board are a vector of the number of forces that drive it in the direction in which it goes.

Dr. Needler: Mr. Chairman, might I say just one word on this. I think it is very easy to under-estimate the impact of the other parts of the Fisheries Ministry on the board program, if one does not understand that there is very, very close contact between the personnel of the Research Board and the departmental personnel at all levels. I have been a director of a board research station long enough to know that the ideas of the board's scientists themselves as to what needs to be learned are influenced to quite a degree by these contacts with departmental people at all levels. So that some of the projects that Dr. Hayes characterized as being proposed by the directors and scientists of the Fisheries Research Board are also influenced quite considerably by a knowledge of what the industry's problems are through the department. It is really quite a close relationship.

The Chairman: But you have no power of review as deputy minister over the decisions of the board in terms of the research projects?

Dr. Needler: Only because of the deputy minister's relationship with the minister, who, of course, has that power.

Senator Belisle: We heard yesterday and today that your funds are limited, and quite rightly so, but I was surprised to read in paragraph (4) at page 57 of Part II that as an achievement in basic research the FRB has been responsible for the production of a number of textbooks. Is this really relevant to your function? Are these text books for trained biologists at the primary or secondary level?

Dr. Hayes: These are not text books for university students. One is on the fishes of the Atlantic coast, and one that is in the course of preparation is on the fishes of the Pacific coast. They are types of books of this nature. They are not elementary text books for university students, but reference works of a systematic nature. It could be argued that some of these could have been put out by the National Museum of Canada, but the board has a long history of interest in the systematics of fishes.

Dr. Needler: The last two mentioned are books on methods which are essential for the board's own work, and even for the department's work. They are for fisheries especially. *Methodology of Assessing the Dynamics of Exploited Fish Population* is simply a book on the sort of things a board has to do in developing conservation recommendations.

Senator Belisle: Could this information not be given to the Queen's Printer and have the Queen's Printer print the book?

Dr. Needler: These are printed by the Queen's Printer.

Senator Bourget: If an industry comes to the Fisheries Research Board and asks you to undertake special research, would the industry share in the cost of the studies made?

Dr. Hayes: The industry?

Senator Bourget: The industry. If it were a special problem they have to face?

Dr. Hayes: I do not recall any instance in which we have ever received a cash contribution from the industry, but I am subject to amplification on that.

The Chairman: You are giving something to them.

Dr. Hayes: Yes. We have worked sometimes in industrial laboratories.

Senator Robichaud: They make the facilities available?

Dr. Hayes: They make available their facilities. For example, we have a board researcher stationed in Lunenburg attached to the St. Andrews laboratory, who is conducting his research there with permission.

Senator Kinley: Do the industry pay him?

Dr. Hayes: He is an employee of the FRB.

Senator Kinley: At Lunenburg?

Dr. Hayes: Yes, that is the man.

Senator MacKenzie: We are always learning something.

Dr. Hayes: We conduct on-premises research, for example, into methods of refrigeration and preservation, but I do not think we have received a cash return.

The Chairman: You would appreciate these applications in terms of your own priorities when they come from industry as from any other source?

Dr. Hayes: That is correct. For example, the east coast industry requested us to make an analysis of herring meal and its food value, nutritional value, properties and so on. We in our turn asked the Department of Agriculture in the University of British Columbia, who were conducting feeding experiments with these materials on poultry and so on, to conduct the feeding experiments for us.

Senator Bourget: Does the industry help by giving grants, subsidies or bursaries to students in universities?

Dr. Hayes: No, sir, I do not think so.

Senator MacKenzie: B.C. Packers did provide some money for this kind of work, and it was because of the contributions made that we were able to bring Professor Hoar out in the first instance to the west coast. The industry has also contributed to work in the Institutes of Fisheries and Oceanography.

Dr. Needler: I believe the Fisheries Council has at certain times assisted students, but I think you would have to discover the details of this from them.

Senator Bourget: I was concerned more with industry and what the industry will contribute to the universities.

Senator Kinnear: I do not think many have referred to pollution this morning, but throughout both briefs the subject of pollution is ever present and I should like to reintroduce it and ask something about the Great Lakes and southern Ontario. I notice that both Dr. Hayes and Dr. Needler talked about the over-fertilized lakes. I presume both were probably referring to Lake Erie. At one time it was a very lucrative lake for commercial fishermen but now it is not. There was in it a great variety of fish; when I was at school it was said there was a greater variety of fish in it than in any other lake known in Canada. Today the fish in Lake Erie have been depleted quite rapidly, and I am afraid that part of the cause is pollution. Perhaps you would like to make an observation on that statement. Are we losing a great many varieties from pollution in Lake Erie?

Dr. Needler: The pollution in Lake Erie has undoubtedly had some effect on certain species, and unfortunately on some of the species that are in greatest demand.

Senator Kinnear: White fish for instance?

Dr. Needler: Yes, and pickerel. Actually the total poundage of fish production from Lake Erie has gone down and we find ourselves faced with a marketing problem.

Senator Kinnear: I was interested in the variety. If you want to get poundage all you have to do is think of smelts, which are dreadful.

Dr. Needler: Well, Olmstead Fisheries are processing and selling them. I think it is undoubtedly true that some of the most prized species have been seriously affected. Dr. Hayes has already mentioned that one of the effects of over-fertilization of the lake is that some of the species we like best are those living in rather unproductive cold, clear

lakes, such as trout, and this sort of fish is often the first to disappear.

Senator Kinnear: I am regularly asked, "Are the fish from Lake Erie good to eat?" This is a serious question. These people think the lake is not fit to swim in and they will not eat the fish from it. I should like to have your opinion on the quality. I know they are fit to eat, though I do not eat them.

Senator Bourget: You do not take any chances.

Senator Kinnear: No.

Dr. Needler: Mr. Chairman, it is unfair to ask the Deputy Minister of Fisheries what kind of fish he likes! I am a great fish eater. I like all kinds of fish. I have had some fish from Lake Erie that I found excellent, even during the last month or two.

Senator Kinnear: People ask me that all the time and I tell them they are fine, and also that you can swim in the lake.

Dr. Needler: I think you are quite right.

Dr. Hayes: Perhaps I could add a word. This is an extremely difficult question, because there are many parts of the world, in Asia and so on, where people are attempting to build up the fertility of lakes in order to get these kinds of fish that we in Canada do not consider the prized fish. If we could produce a Lake Erie kind of situation in a great many parts of the world and obtain a supply of animal protein it would be considered a national triumph. We have so much excessive food that we say we will go to unproductive lakes and try to get out trout and something like this rather than increase the fish production by fertility. This is a national choice we make in Canada at this moment, but the question is a world question and is not at all clear. This is not called pollution in most parts of the world.

Senator Kinnear: I understand that for instance one of the fishes we do not use in Canada very much is cod. This is a desired fish in many of the other countries.

Yesterday we were told that the usual research on pollution was going to be postponed indefinitely and I found that quite a shocking statement that we are going to postpone solving the solution.

The Chairman: I think you are slightly exaggerating what the Department of...

Senator Kinnear: Postponed indefinitely.

The Chairman: I understand they are already doing some research but they have to postpone extending that kind of research. That is what I understood, but in any case this was a statement which was made yesterday afternoon by the people from the Department of Energy, Mines and Resources.

Senator Kinnear: I imagine they are postponing a permanent building in Burlington for their experiments, because we have been told they are in temporary buildings and have only one ship. I see that ship very often in the summer. What is your comment on that? What kind of postponement are we having? Are we at the *status quo* or are we going to develop...

Dr. Hayes: As I remarked earlier we have been publishing on pollution since 1901 and we have no intention of discontinuing our record which has been going on since that time. We have a pollution establishment at St. Andrews, New Brunswick in our laboratory there. We have a pollution establishment in our laboratory at Nanaimo on the Pacific coast and we have an expanding program in our Winnipeg laboratory and administratively reporting through our Winnipeg laboratory. We have a program at the centre in Burlington which was referred to yesterday, and in all these areas we are continuing our pollution work and extending it at the expense of other programs in the central area.

We are re-orienting our program of there is a higher priority for some programs, we expand our work there at the expense of other fields in the central area. Some programs are holding the line on the east and west coast and at the moment expanding in the centre. This is being done at the expense of other programs in the present financial circumstances.

Senator Kinnear: Speaking specifically of the Great Lakes area in which it was said it was being postponed indefinitely, that worried me a great deal. I think that pollution was covered pretty thoroughly by other members of the committee.

Dr. Needler, you did answer me the other day on the DDT spraying of the spruce trees for the budworm and I notice five million acres were to be covered by that. This is a tremendous number and no wonder there is a great residue of DDT. When it runs off into

the streams it is certainly harmful, as you suggested.

Dr. Needler: As Dr. Prebble confirmed yesterday, in the spruce budworm spraying we are getting away pretty completely from DDT to other sprays, other pesticides that are less damaging to fish and are less permanent. I think we are making progress towards the use of pesticides which will disintegrate and will not accumulate. In my opinion this is extremely important and I am glad we are making progress.

Senator Robichaud: In relation to the question by Senator Kinnear, particularly concerning the fresh water of the Great Lakes, it might be interesting to refer to page 128 of the Part II of the Fisheries Research Board brief where it shows that the expenditures by the board in the laboratory in Winnipeg in 1962-63 was $362,000; in 1965-66 was $511,000 and in 1968-69, $2,065,000. It shows the increased effort that the board is taking regarding fresh water research. I am interested in having those figures on record.

Senator MacKenzie: I have a number of questions here, but in view of the time and type of question I think that I will leave most of them for a private conversation with some of my friends.

The Chairman: You will have the afternoon meeting.

Senator MacKenzie: I would like to raise a point on the general question of conservation and control, both at the national and international levels. To what extent or degree are stocks being depleted for catching fish in the seas? I have in mind, for instance, the whale fisheries in the Pacific and I gather in the Antarctic and Arctic as well. I have in mind the fact that while they are not fish they are an illustration.

At one time the sea otter was, I believe, a very valuable product on the west coast and has almost completely disappeared. There are from time to time statements made in the press to the effect that there is over-fishing on the banks of Canada by fishing boats of other nations and so on. I would myself feel that about the only way you can achieve control of this is through international treaties and international commissions, boards and bodies of this kind. That has been done in respect of the halibut and the salmon on the west coast and the seals in the Pribilof Islands. I do not think we have anything on whales internationally that is effective and I do not know if we are getting it in respect of fishing off the Grand Banks and in terms of the trawlers belonging to other nations coming in. Would you say a word about this.

Dr. Needler: This is a very big subject but of course it is an important one. It has always been Canada's policy in fisheries, as I think in other matters, to support collective international approaches to the solution of problems and this is certainly true of fisheries. As a result, a number of international commissions have been set up and each one of these is based on a treaty to study certain fisheries problems and Canada is a member of a number of these. Some of them have been notably successful. The most successful of these has been co-operation between the United States and ourselves in which we have people that think somewhat alike, not always completely, and have standards of living that are somewhat similar.

Another that has been outstandingly successful has to do with the fur seals. In the case of fur seals there are not really strong economic pressures in any of the four countries concerned, Japan, Russia, Canada and the United States. There are pressures but they are not as strong as, say, the pressures from 80,000 fishermen in Canada. The killing is done by the United States Government and the measures taken have been such as to increase the herds considerably. I would judge that this is true now, more recently, in the Russian Islands as well as the United States Islands which have seal reproduction.

Actually, our only part in this has been a little bit of scientific co-operation and refraining from catching them when they are in our areas and getting our share there.

At the other extreme, I would think the International Whaling Agreement—and this is another treaty—has been much less successful. In the Antarctic area, they have finally reached the stage now that the stocks are greatly reduced, and production is limited to a level which will not reduce them further. In other words, they have finally at last accepted the estimates of the scientists and they are doing this. Why didn't they do it before? I think that was because there was so much economic momentum in the operations of the

big whaling nations—Norway, Japan and USRR, and the UK were in this, too.

The two which seemed to have been most consistent in continuing this fishery were Japan and USSR. The investments were tremendous, a lot of them were in ships which could not be used for anything else—so there was a lot of economic momentum and a lot of resistance to restrictions which would lead to economic loss.

People point to this as a failure of international regulation—I think, rightly. On the other hand, in the North Atlantic, under these agreements, at the moment mother ship operations are prohibited in the north Atlantic. We have on the Atlantic coast of Canada a stock of fin whales which we are using to support an industry worth $2 million, one of the profitable fishing industries in Newfoundland at the moment and where Canada, because of this regulation under this international convention, is the sole exploiter and we have been able to limit our take to what seems to be this magic maximum sustainable yield. We are not depleting these stocks, so it may be that even under these agreements there is some hope for the future. There is, however, I believe—and this is a personal opinion, based on taking part with organizations such as FAO and so forth over the years—I think there is a race going on between the extension of jurisdictions and effect of international regulation. There has been a steady tendency for countries around the world to claim more water.

Senator MacKenzie: Peru and the west coast of South America go up to 500 miles.

Dr. Needler: They say "200 miles or as far as necessary". India and Pakistan, I believe, claim 100 miles. I would say that when we declared our 12-mile fishing zone there were about half, or less than half with such a zone: now there are far more than half, so much so that this 12-mile limit is accepted.

Where the nations have got together in the past under the United Nations agencies to discuss these matters, the law of the sea, the net result has always been some extension of jurisdictions. It may be that they have slowed the process down, slowed some of the unilateral claims down; but the net effect has been the extension of jurisdictions. The continental shelf mineral resources, for example, was the largest big agreement. Therefore, there are these two forces going on in an attempt to make international conservation work, in which Canada is doing its best, and a general trend towards extension of claims for exclusive fishing rights.

Personally I think that, at the moment, it is very difficult to guess which one of these will win, but some of the international operations are becoming more effective, but on the other hand the tendency towards extension of jurisdictions is continuing. I do not want to go any further.

Senator MacKenzie: What about the alleged depletion of the fishing on the Grand Banks or over-fishing for some types of fish?

Dr. Needler: The scientists have reached the stage, as I understand it, of agreeing that some of these stocks are over-fished, in the sense that there would be more of an overall net profit if fishing were decreased.

I believe that, except for a very few of the Atlantic stocks, the west Atlantic stocks, they have not yet agreed that they are over-fished, in the sense that the total poundage taken is less than it should be. But you must realize that, from the very start, you start fishing a virgin stock, from the very start the fish start to get scarcer and it starts to get more expensive to fish. In some cases, fisheries have reached an uneconomic level before you reach the maximum take. Therefore, in these fisheries, the economic factors are more important really than the biological factors. But, biological depletion in the sence of more pounds being taken out than the stocks can maintain, is true of only a very small proportion of the ground fish stock in the Atlantic so far. I think this is the scientific consensus. But economic depletion in the sense of fish becoming more expensive, harder and more expensive to catch, is hitting a number of countries and it hits the countries differently, depending on their economic regimes.

The Chairman: Senator MacKenzie, have you a short question? I ask that because we would like to adjourn at 12.30.

Senator MacKenzie: Yes, my question is quite short.

Dr. Needler: Perhaps I have been talking too long.

Senator MacKenzie: What is the effect of the use of different types of gear on the bottom? It has been suggested, for instance, that

dragging has an effect on the bottom in relation to lobsters and other ground fish.

Dr. Needler: Personally, I do not believe that this is a serious factor. Although there have been some regulations to reduce the taking of small fish. I do not think that the destruction of the environment is a very serious matter.

Senator MacKenzie: This does not seriously affect...

Dr. Needler: There are some differences of opinion on this. I am just giving my personal opinion. I do not think this is a very serious factor.

The Chairman: We will adjourn until 3.30.

The committee adjourned.

AFTERNOON SITTING

(Second and Final session)

3.30 p.m. Thursday, 12 Dec. 68

The Chairman: Senator MacKenzie.

Senator MacKenzie: These are not very important questions in some ways, but I would be interested in finding out if any new information has been obtained with respect to the attempts to find lobsters on the west coast. There have been, I think it is in its third experimental stage now dating back to before World War I, or soon after that.

Dr. Hayes: I have lost count of the number of times it has been tried, but they have all been unsuccessful up to the present time.

There is an inlet on the west coast of Vancouver Island called Fatty Basin into which the transfer of lobsters from the east coast was made and they have established a small experimental lobster hatchery there to try to rear some of the young. This is being done successfully and they are following the population of lobsters in Fatty Basin.

So far the population of lobsters is still there. There are some difficulties with predators.

Senator MacKenzie: Mink and so on?

Dr. Hayes: Yes.

Senator MacKenzie: Are these mink actually catching some lobsters?

Dr. Hayes: Apparently the mink are catching some of these lobsters and the hope is to establish stock that will perpetuate itself, but I do not say that this has been done yet.

Senator MacKenzie: Is this a new skill on the part of mink?

Dr. Hayes: I suppose that mink is more valuable, if possible, than lobster.

Senator Robichaud: They recognize the good flavour of Atlantic lobster.

Senator MacKenzie: A second and somewhat similar question: is the Fisheries Research Board or the Department of Fisheries responsible for the introduction of the oysters from Japan to British Columbia?

Dr. Hayes: I do not know who introduced the oysters.

Dr. Needler: I believe, Mr. Chairman, that that was done first by commercial operators in the State of Washington and that the practice of importing seed from Japan was followed up by commercial operators in British Columbia. Then finally they became re-established on a sustained basis.

Senator MacKenzie: It has proved to be very successful.

Dr. Needler: Oh, yes.

Senator MacKenzie: In one season they practically took over the whole of the west coast.

Has anything ever been done to try to get a better oyster, the Atlantic oyster, out on that coast?

Dr. Needler: That, too, has been tried, Mr. Chairman, but unsuccessfully.

Senator MacKenzie: They cannot compete with the Japanese. I have only two other questions: is it a fact that 75 or 100 years ago salmon came up into Lake Ontario and up the streams flowing into that lake and were caught in those streams north of Toronto?

Dr. Needler: Yes, that is true.

Senator MacKenzie: Has it been pollution or other causes that have stopped that?

Dr. Needler: I think the most probable reason is silting of the streams due to the clearing of the land; that is the most important factor, in terms of the farming.

Senator MacKenzie: The hatching?

Dr. Needler: Yes.

Senator MacKenzie: The other one is: Dalhousie University is planning to build what they call a life-science building, an aquatron, which is for them and the Province of Nova Scotia a very expensive operation.

Is that type of facility useful, essential, desirable, or is this an embarrassing question? If so, I would not expect an answer. You and I both have a sort of an interest in that particular institution.

Dr. Hayes: I have no particular hesitation in answering you. As a professor I was at the time mainly responsible for the initial promotion of the aquatron, so I am perhaps not wholly objective.

The Chairman: Now that you have declared your interests or your bias.

Dr. Hayes: Now that I have declared my bias, I will say this, that there is a great deal of requirement for a laboratory which provides running sea water and full laboratory facilities in which to experiment on marine animals. There are several of these on the east coast; we have had such a place in St. Andrews, of course, for many years. There is the proposed aquatron in Dalhousie, which will bring to the campus water drawn from the Northwest Arm. If you get into the depths of the Northwest Arm, you can get reasonably bacteria-free water; it is quite satisfactory in quality.

There is one already installed at Memorial University and I think that any university which purports to specialize in marine science should have an effective supply of sea water so that they can conduct experiments with these marine animals.

If this can be done at Dalhousie right on the campus, then the students can go from their other classes to their experiments and conduct their research on that campus, there is a great tactical advantage instead of having to go somewhere down the coast to do it.

I think that this will be a centre which will attract not only Dalhousie professors and students, but others as well and I think it should be a considerable advance in our opportunities to study marine forms in the east coast.

Senator MacKenzie: I think you know, I had some responsibility being Chairman of the University Grants Committee of that province about recommending or not recommending that this project be proceeded with and I feel that your support of it would be invaluable if the money can be found.

Dr. Hayes: Yes, I am sure it is.

Senator MacKenzie: I will not ask you the question as to whether the federal government could make available more money than it has indicated it might be willing to do for that project, because that is outside your field.

Dr. Hayes: Yes sir; I am very much interested in the project, of course.

I may say that the University of Victoria has also an attempt, I say an attempt because they have a stretch of one mile from the coast to bring sea water in order to have a running water facility on the campus. They would like to try; it is getting into engineering difficulties when you start bringing sea water from a mile of pipe line, because you get growths of barnacles and things inside, and there are other troubles of various kinds, but they would like to do that same thing there.

Senator MacKenzie: Is the aquarium in Vancouver useful for your kind of work?

Dr. Hayes: It is useful as far as running sea water is concerned but it is fully occupied by their own use. They did have an extension of the aquarium a year or two ago and this made some more space but it does not really supply the need for the University of British Columbia for scientific personnel because there just is not enough space there.

Senator MacKenzie: But it could?

Dr. Hayes: The sea water is satisfactory.

Senator MacKenzie: And to a point does serve the purpose?

Dr. Hayes: And some of the people from UBC do go down there.

Senator MacKenzie: Yes, I know that. Thank you, Mr. Chairman.

Senator Bourget: I understand that the administration of fisheries is the responsibility of the federal government through your department except for Quebec. Now, coming from Quebec, as the Chairman does too, I

would like to know if there is some kind of working agreement with the Fisheries Department of Quebec and your department, and later on I would like to ask Dr. Hayes if there is also some connection between your research board and some organization that they have in Quebec also.

Dr. Needler: Mr. Chairman, the fisheries jurisdiction is universally federal and there has been a delegation of responsibility for both salt and fresh water fish in Quebec, and for fresh water fish in Ontario, the Prairie Provinces and British Columbia.

We have quite a lot of co-operation with the province of Quebec. In the regulation of in-shore fisheries, of course, they carry this out on their own but with exchange of information in exploratory projects and the testing of new fishing methods and that sort of thing we have some cost sharing arrangements with Quebec.

In the consideration of fisheries questions in general there is a federal-provincial committee of deputy ministers concerned with fisheries of the five Atlantic provinces, including Quebec and the federal government, which meets at least once a year and has some sub-committees, so that there is a lot of communication with Quebec on fisheries problems.

The Chairman: Did this delegation of authority involve also some kind of financial compensation?

Dr. Needler: I would hate to be definite about this, because I have not looked up the record, but I do not think so; I think that the province of Quebec simply assumed the responsibility and paid the costs through a mutual arrangement.

Actually this arrangement extended to fish inspection at one time, but that was changed again so that the federal government took it over. Inspection is not usually regarded as one of the more...

The Chairman: Glamorous?

Dr. Needler: Glamorous things, no.

Senator Bourget: What about research; what kind of arrangements have you got with the Quebec Fisheries Department?

Dr. Hayes: I do not know that we have a very different kind of association than we have with any other provincial department and that is on an informal basis. We do not do very much research in the field of biological research, perhaps because the province has taken over its own work in fisheries. We have a technological station which is located at Grand Riviere and which is immediately adjacent to a provincial biological station; these two groups of people communicate.

Our technological station is programmed scientically in conjuction with the Halifax laboratory and has certain features of technological work assigned to it. Like all our laboratories it is a national laboratory; it has some relation to local needs but it is carrying out a national programme on certain lines of work and so is the Halifax laboratory doing other lines of work and they are both applicable in all areas but I would not say that we have...

Senator Bourget: You have no joint research project between the two?

Dr. Hayes: I do not think so; have we, Dr. Martin?

The Chairman: But insofar as you are concerned, Quebec is a province like the others; there is no special arrangement, there has been no delegation of authority insofar as your research programmes are concerned?

Dr. Hayes: That is correct.

The Chairman: But in your case there has been special delegation.

Dr. Needler: Yes; this is delegation of the regulatory authority, the responsibility under The Fisheries Act specifically.

The Chairman: But in term sof research; for instance, I saw in your tables that insofar as the department is concerned there is very little research being done in the province of Quebec.

Dr. Needler: I think that is a fair statement.

The Chairman: Is it part of the delegation of authority?

Dr. Needler: Our industrial inspection service has carried out a project jointly with Quebec and our inspection people have carried out some investigations there.

Senator Robichaud: Due to the fact that the value of the commercial fisheries in Quebec is

very limited and as the experiments which are being made in the Gulf of St. Lawrence, benefit all of the Atlantic provinces and Quebec, this might explain why the amount assigned to Quebec might seem limited.

Senator Bourget: But as a matter of fact they do benefit by all the research made through the Research Board; all your papers, I suppose, are sent to the Fisheries Department in Quebec?

Dr. Needler: Oh, yes; of course.

The Chairman: But would the Fisheries Department in Quebec do more research in this field than other provincial governments?

Dr. Needler: I think Quebec is the only province that does any salt water biological research directly related to fisheries.

Dr. Hayes: I think Quebec is the only province that does any technological research; they have a technological control lab and I do not think any other province has; but values of the fisheries of Quebec are something like 4% of the Atlantic values. This is a small fraction and I think that is why originally together with the province having taken over its administration of its fisheries that we have not done very much. Of course, investigations in the Gulf are used by all provinces and we have work on the Gulf going on of various natures.

The Chairman: How many schools of fisheries exist in Canada attached to universities?

Dr. Hayes: There is only one under that name and that is the University of British Columbia; that is a graduate school. There is no undergraduate course in fisheries that I know of.

The Chairman: But what about the one which was attached to Laval?

Dr. Hayes: I do not think that was a degree course; this was a practical course for fishermen.

Dr. Needler: It was a degree course.

Senator Robichaud: On that very point, should we not put on the record that courses in fisheries are being given at the University of St. Johns, Newfoundland, the Caraquet Fisheries School, the Pictou Fisheries School, and to some extent at Grand Riviere, Quebec.

The Chairman: I am speaking now at the university level; this would not be at university level.

Dr. Hayes: No.

Senator Robichaud: I would like to ask Dr. Favre if the University of Montreal or Laval are doing some research in fisheries?

Dr. Favre: I can answer this for the University of Montreal; sure, we are doing some fundamental work which will have some bearing, some remote connections with fisheries, but we are not really doing any direct research on fisheries and I think it is the same thing at Laval.

Also I believe that there is at Laval University some interest in fishing gear and developing the engineering side of fisheries, but we can say that we are really contributing to the research effort as far as the fundamental biology is concerned.

Senator Bourget: All the research that is done at either Laval or Montreal, is that paid entirely by Laval or are you getting grants also, either from the Research Board or the department or any other federal organization?

Dr. Favre: Not at the University of Montreal; we are not getting direct grants to carry on this research.

Senator Robichaud: Mr. Chairman, we have been talking about the relationship between the federal Department of Fisheries, and the Research Board and the provinces. I think that we should also have some information regarding the relationship in the research field with other major fishing countries.

On page 3, paragraph 10 of the submission by Dr. Hayes this morning, it is stated that:

> With its relatively small population, Canada cannot afford to emulate the United States or the Soviet Union in lavish support for all branches of science. Canada's resources in men and money, its geography and its needs, all force it to concentrate on outstanding achievement in specialized fields. In keeping with this, the Fisheries Research Board has focused its attention on particular areas of scientific research.

Now, my question would be: do we take advantage of the research which is being done in fisheries by other major fishing

nations such as the USSR, Japan, the United States? Do we exchange scientific data with those countries and do we also try to avoid duplication of effort?

In other words, if we get satisfactory information from them on herring research, for example, do we avoid duplication of similar efforts on our part?

Dr. Hayes: Yes, sir. I believe Dr. Martin is familiar with this particular topic and I would ask him to comment on it.

Dr. Martin: Mr. Chairman, I think it would be fair to say that the leading countries in the world in fisheries research are the USA, USSR, the United Kingdom, Japan, Germany and our communication is good with virtually all of these countries.

For the North Atlantic area Canada has now joined the International Council for the Exploration of the Sea and this long-established international organization brings together all the countries concerned with the North Atlantic at annual meetings and at committee meetings. There is good communication on all phases of fisheries research going on in the North Atlantic.

In the North Pacific area we have had good communication with Japan and the USA through the International North Pacific Fisheries Commission. I think there is something to be gained by better communication with the USSR in the Pacific and some of our scientists would welcome development of an international council similar to that in the Atlantic area for the Pacific in order that we could have better information concerning USSR fisheries statistics and fisheries research in the North Pacific area.

Our communication with the United States is excellent, of course, since the general distribution of our population in Canada is such that our scientists tend to communicate easily north and south with the United States scientists concerned with similar problems.

On your point of avoiding duplication, I might note as an example our consideration in the Fisheries Research Board during the past year of the best approach to improving our techniques for the harvesting of fish. In this area we recognize the need for more research on fishing gear and more research on fish behaviour.

We noted that research on fishing gear is very expensive and very well developed in Germany, for example. It was felt that it would be unwise for Canada to try to mount a very costly programme to duplicate and compete with that kind of gear research. On the other hand it was decided that the general weakness in this area, around the world, was in better understanding of fish behaviour in relation to gear. On this basis the Board will try to move ahead with its own programme in this particular field.

So in summary I would say, sir, that the communication with the other leading countries in fisheries research is very good indeed and we profit from their experiences.

Senator Robichaud: Have we gone as far in the past as exchanging scientists, and sending some of our scientists to foreign countries for a specific period of time in order to acquaint themselves with the findings of those countries?

Dr. Martin: Yes, Mr. Chairman; we have a programme of sabbatical leave in the Fisheries Research Board and our scientists are taking advantage of this arrangement to go to other countries, for a year normally, with their families and they become familiar with the programmes there.

We have one proposal at the moment that one of our scientists go to USSR for six months within the next year and we hope that this can be accomplished in order to promote this communication that has been a little weaker with the USSR than with other countries.

Senator Belisle: Would you take comparison knowing that we are speaking about the international relationship to the other countries compared to ours, knowing that the total quantity caught has not increased whereas the investment in new vessels has multiplied and the labour force has multiplied and our catch is dropping; is it the same problem with other countries?

Dr. Needler: Mr. Chairman, our catch is not dropping.

Senator Belisle: Well, I'm reading from the *Globe and Mail* here; I hope that it is not in the gospel yet.

The Chairman: Perhaps for you, but not for us.

Dr. Needler: I want to make just two points very briefly: catches of certain species are

dropping but our total catches have been going up.

I would also say that from what we can learn of some of these large-scale long-distance fishing operations their returns per ton of shipping or per man, whatever assessment can be made, do not appear to be as efficient as ours. The USSR operation in particular I have in mind is probably not successful enough to exist under our conditions where they have to pay all; they depend really on government support.

Senator Belisle: Could I correct myself, Mr. Chairman: I was reading from the *Globe and Mail*, but I was reading a quotation from the Minister.

The Chairman: Are you sure that the quotation is correct?

Senator Belisle: Of course I was not around, but it was said.

Senator Robichaud: Mr. Chairman, I have two more questions; one has to do with herring and the other with queen crab. First, referring to the situation of the herring fishery, it is a well-known fact that on the Atlantic coast we have had in recent years a rapidly expanding fishery. I do not have the figures in front of me, but I believe that the catch in 1968, for example, might be 15 or 20 times what it was five or six years ago. So there is certainly no drop in this particular fishery. On the other hand, on the Pacific coast the fishery has difficulties; the catch has gone down substantially.

Now, also statements have been made, they have been made even in the Senate, to the effect that not enough research was being done regarding the herring fishery. I would appreciate it if Dr. Hayes could put on record the activities of the Fisheries Research Board regarding research on herring?

Dr. Hayes: I think if I may I will ask Dr. Martin to put this into the record.

Dr. Martin: Mr. Chairman, the Fisheries Research Board has been increasing its research activity in herring on both coasts. We are very much concerned about the drop in the availability of herring on the Pacific coast, and with the co-operation of the development service of the Department of Fisheries, we have been able to mount a programme to look into the availability of herring off shore in the Pacific area in order to determine whether or not there is a separate resource that might be exploited there. To date there is no indication that such is the case.

We feel that the fishery is subject to a series of poor year classes and through a herring management committee on the Pacific coast the situation is being followed closely. It is expected that that fishery will return to normal as new year classes come back into the fishery.

Now, on the Atlantic coast we have a new explosion of a herring industry concerned at the moment with the production of fish meal and hopefully the production of fish protein concentrate and in the long run hopefully the use of more and more of this herring for human consumption.

There has been a great deal of interest on the part of industry and government in the state of the total resources on the Atlantic in relation to this expanding fishery and because of this concern we have increased our herring research programmes at three, or in fact, four of our Atlantic coast laboratories.

The key problems as far as the resource is concerned are the division of stocks, the relationship of herring exploited by various countries on Georges Bank to those taken inshore by Canadians in Nova Scotia and the relationship of those in turn to the stocks in the Gulf of St. Lawrence and the south coast of Newfoundland.

Secondly, we are very much concerned with the total size of the resource, the potential for expansion, and learning something about the potential sustained yield. Through surveys using echo sounders and the studies of the changes in the ages and sizes of the fish during the development of this fishery, we hope that we will be in a good position to advise industry and the government on the long term future. At the moment there is every indication that there is a big potential for continued expansion of the fishery. Now that intensive fishing has reduced the size of cod, cod are less dependent on herring as a food fish and we now have more of these herring for use by man.

We think that the long term trend will be toward increasing landings of herring and indeed other species from the North Atlantic,

and it is hoped that Canada can be competitive in the efficiency of its fishing methods and utilization of this resource, and that the Canadian fisheries will continue to expand in that area.

The Chairman: I do not know what the herrings think of the change.

Senator Robichaud: Is it not a fact that also due to the limited efforts by Canadian fishermen to fish herring on the Atlantic coast it was found out that a good percentage of the herring population were dying of old age?

Dr. Martin: While I think that is a reasonable statement, we find that in general we get the best production from these resources by cropping them before they reach old age, before the growth rate slows down and mortality goes to other factors than mortality due to man.

The Chairman: What about these new methods of fishing, the use of the dolphin, for instance, to bring the fish to the fishermen, and the use of language or noises to attract the fish and all this that we hear bout being developed in Europe and also in Japan; are you doing any research on this?

Dr. Martin: While, Mr. Chairman, we are very much interested in this subject, at the moment the big development on the Atlantic is resulting from the introduction of efficient, well-known gear, such as purse seines and midwater trawls, but the Board has recognized the importance of these fish behaviour studies and is attempting to mount a programme based in our laboratory at St. Andrews, N.B.

In the work already done they have shown the importance of sound, for example, in the attraction of cod and hopefully in the long run the results of these experiments will be useful in the development of fishing methods.

The Chairman: What are the prospects of developing here in Canada what I think in Great Britain they are experimenting with: sea farms connected with nuclear energy power plants; have you heard about this?

Dr. Hayes: These are warm water areas in Britain in which either through thermal or nuclear power the whole bay is heated up by the effluent. This has attracted a good deal of attention and there have been some efforts made in Britain to rear high priced specialty fish which might be brought to a uniform size for marketing, like chicks are for example, and then sold.

This can be done experimentally; it might also be possible in Britain to rear some warm water forms which you could normally bring along in their waters if you had some of this warm water effluent.

My own opinion is that the fraction of the coastal water which is warmed is really so small that, although it is noticeable and one seems to be getting something for nothing, the fraction of water is so small in proportion to the whole coast that they will not really make any real impact; it is a stunt that gains public support for research, which perhaps is a good thing in itself.

The Chairman: So you do not believe very much in the seriousness of these projects?

Dr. Hayes: I have some doubts, yes.

Senator Robichaud: Mr. Chairman, before I go to my last question, on crab meat, I might relate an interesting incident with regard to the behaviour of fish, an incident which happened when I had the responsibility as Minister of Fisheries. In July 1967 when we had one of the unusual warm summers and when the temperature of the water in Chaleur Bay was seven or eight degrees above normal for that period of the year, the herring catch inshore was almost nil and the fishermen were blaming it on the seiners operating in the area. I tried, without too much success, to convince the fishermen that the reason for the poor catch of fish was due do the temperature of the water being too high.

Two weeks later, when the temperature was still much above normal, the lobster catch 100 miles away was also much below average. It was the worst season in the last 25 years and I had to make a public statement trying to convince the fishermen that the reason they were not catching lobsters was because the water was too cold. The fact is that the water was really warmer at the surface but the bottom water in Northumberland Strait was six or seven degrees colder than normal and lobsters were not moving.

Now I will come back to the crab fishery which, as we all know, is a new venture for the fishing industry on the Atlantic coast. Following experiments which were carried out by the federal Department of Fisheries, in

co-operation with the provinces, it was discovered that there are very substantial quantities of crab in the Gulf of St. Lawrence waters.

As a result of fishing and processing experiments which were carried on in 1965, 1966 and 1967, I understand that in 1968 ten plants were processing what we call Queen Crab in the province of New Brunswick alone and the total catch amounted to something over six million pounds.

There has been so much interest in this particular fishery that I am seriously concerned with its future.

Right now in a very limited area four new crab plants are under construction and ten more are being considered. In other words, in 1969 there could be 22 processing plants engaged in the processing of crab meat in New Brunswick alone.

Those plants could only operate if we have the production. The number of fishing boats available for this type of fishing is very limited. I would venture to say that 60% or maybe more, maybe 70% of the type of vessel available for this type of fishery were engaged in crab fishery at least in the latter part of the season of 1968. If the plants which will be in operation in 1969 have to be supplied with crabs, this will involve a total catch of instead of 6,000,000 pounds probably sixteen to 20 million pounds of crab.

Has any research been done to determine if there will be sufficient yield or sufficient production to allow such an operation and furthermore, is there any thought of controlling this type of fishing? We can easily understand that if the industry is allowed to put capital investment into processing plants to the extent that it appears they are doing now, there will be lack of fishing boats to supply the production; it will be wasted money and most unfortunately some of those plants may be built under the ARDA or ADA programme, with some federal assistance. So what is really being done in order to control this type of fishery?

Dr. Needler: Mr. Chairman, we are getting a little away from research, but I think both the Federal and New Brunswick fisheries administrations have been advising against an expansion of plants at the present time. The New Brunswick administration has even been advising fishermen against conversion of some of the vessels to crab fishing.

I do think, however, that this sort of happening emphasizes the need for a really broad knowledge of what there is in the sea and not only in a quantitative way, but in a qualitative way, the size of these resources, their position in the whole economy, the biological economy of the sea. We are an awfully long way from having such a complete background on which to plan our fisheries development. I think there is a need for it.

I believe that the Research Board has initiated some biological studies of the Queen Crab, so-called, and perhaps Dr. Martin or Hayes can answer that part of the question.

Senator Robichaud: Before Dr. Hayes answers that question, are there not also attempts by other provinces, like Prince Edward Island, Quebec and Nova Scotia, to get involved also in the processing of crab and are they not all getting their production from the same area?

Dr. Needler: This is true; they are all engaged, although I would say maybe not quite so actively as northern New Brunswick and also the east coast of Newfoundland, which would presumably involve a completely separate stock.

Dr. Martin: Mr. Chairman, we do have biological programmes at our St. Andrews and St. John's research stations concerned with this new fishery for Queen crab. Biologists, true to form, recommend some caution in the approach to this development. The normal pattern for development of a new fishery such as this is that you take off a standing crop of the resource, so that the catch goes up fairly rapidly, then passes a peak, tapers off and levels off at something like a long term sustained yield.

We have recognized this in so many fisheries that we would expect that some such pattern would also apply to Queen crab, but to assess just where we are in this development of a new fishery is extremely difficult with a fishery and investigation that has been going for a year or so.

We are intensifying our efforts to track these animals, to carry out exploratory fishing for them, and to study their growth and try to make some assessments of the long-term potential.

We feel that the fishery is developing so rapidly in the Gulf of St. Lawrence that we

probably should have some caution in development work there until we know more about it. On the other hand, on the east coast of Newfoundland there is very little, if any, fishing for Queen crab to date, and the biologists know that there is a substantial resource in that area. We might very well see an expansion by moving to a wider area on the Atlantic coast, rather than thinking in terms of an unlimited production in the limited areas of the Gulf of St. Lawrence that have been exploited to date.

Senator Robichaud: Do I understand then that so far we have no specific data on the rate of growth of the crab in the Atlantic?

Dr. Martin: Very weak information to date, sir.

Dr. Needler: The trouble with lobster, Mr. Chairman, is that they do not have scales or anything that shows rings, so it is very difficult.

The Chairman: I will have a few questions to ask; perhaps I might be allowed to recognize myself now.

I wonder if you have with you the total budget of the Department of Fisheries at present including, of course, the expenditures of the Board?

Dr. Needler: Mr. Chairman, we have the printed revised estimates for 1968-69.

The Chairman: In order to compare with the figures we have here, would you have it for 1967-68? I suppose you would have it there.

Dr. Needler: Yes, it is here. Fisheries Research Board of Canada in 1967-68 was $14,829,000; the Fisheries Management and Development, which is the part of the department concerned solely with fisheries, in 1967-68 was $33,979,000.

The Chairman: So that the total in round figures, the total budget of the whole department would be about $47,000,000.

Dr. Needler: Without forestry, yes.

The Chairman: Yes.

Dr. Needler: $48,000,000.

The Chairman: What proportion of the $33,000,000 attributed to the department itself apart from the Board would be spent on research?

Senator Robichaud: Mr. Chairman, perhaps if Dr. Needler would look at page 9, part 3 of his report, 9 and 12 are the same, there is a duplication, it will show that from $2,000,000 in 1962-63, the share of the department was over $6,000,000 in 1968-69.

The Chairman: It would be roughly $20,000,000.

Senator Robichaud: That is right.

Senator MacKenzie: Mr. Chairman, could we get the figures for the revised estimates for 1968-69; I think the figures given were 1967-68.

Dr. Martin: They are both here.

Senator MacKenzie: How much increased is 1968-69?

Dr. Needler: Mr. Chairman, the fisheries management and development funds for 1968-69 are slightly less than for 1967-68.

The Chairman: And what is the total for the revised estimates for 1968-69?

Dr. Needler: Very much the same.

The Chairman: No, but the total for the department, including the Board?

Dr. Needler: About $48,000,000; it was $48,700,000 in 1967-68; $48,100,000 in 1968-69.

The Chairman: So we can say roughly speaking about half of your budget is devoted to R and D?

Dr. Needler: Yes.

The Chairman: Total scientific activities, that would include, of course, data collecting and all of this?

Dr. Needler: Mr. Chairman, it is very hard to distinguish these things. I think that we need an explanation. The figures in this Part 3 include scientific activities, some of which are not research at all. For example, to try to make this sort of distinction in the field of artificial measures to increase salmon, the fish culture methods, the research by the Fisheries Research Board is directed towards discovering the principles which might be used.

When we come to use them, of course, in order to apply those principles we have to

obtain scientific information of a survey type; we have to understand the conditions and so forth. These are really applied scientific studies.

The Chairman: Selection and collection of data?

Dr. Needler: The public in general maybe would consider these research, but they are not research of the same kind.

The Chairman: To be more exact, let us say that you devote a little bit less than 50 per cent of your total budget to scientific activities.

Dr. Needler: Scientific activities, that would be fair to say.

The Chairman: I am sure you do not have the figures here in terms of staff and employment, people engaged in scientific activities in your department and in the board in relation to the total staff of the department.

Dr. Needler: I do not have it.

The Chairman: You could possibly get it?

Dr. Needler: It would be quite possible to get it; I would say that the whole of the research staff, of course, was such. I do not believe we have these figures on personnel.

The Chairman: No, we did not ask for that, but if it were at all possible I think it would be useful to me at least if we could have that kind of distribution.

Dr. Needler: There is a table on the country of origin of the people.

The Chairman: You have the total number of people engaged in scientific activities, but we do not have the total.

Dr. Hayes: You do not have the support staff; you do not have the secretarial staff of the Board either.

The Chairman: They are indirectly engaged in scientific activities, in the sense that they are the support staff.

Dr. Hayes: Here is the Board: total staff, scientists, technicians, administrative, clerical and maintenance, vessel crews, totals 776 employed by the Board out of an authorized 855.

The Chairman: Then what we need is the corresponding information for the department, plus the total staff of the department.

Dr. Needler: I would think that the proportion of the staff in the department who would be considered scientific staff is—

The Chairman: I am still meaning scientific activities.

Dr. Needler: Scientific activities, yes. The difficulty here is that I think we could get a figure for the professional people involved very quickly, but it would be more difficult to get a figure for the people supporting these scientific people.

Senator Robichaud: But is it not a fact that the whole department is invalued in research in some stages or other?

The Chairman: In any case, if you can find some kind of an approximation.

Dr. Hayes: You would like this information?

The Chairman: If this could be sent to our research director, Mr. Pocock.

You have no programme of financial assistance to industry for research or development?

Dr. Needler: Not for research, no.

Senator Robichaud: May I ask a further question on this: you say not for research, but do I not understand that although no cash grants are being made to industry, that it has been said that the Board or the department co-operates by making available their knowledge, or even the services of their staff on certain occasions in order to promote certain developments within the industry?

The Chairman: Some technological developments?

Senator Robichaud: Yes.

The Chairman: But is industry doing any research?

Dr. Needler: I would not say that industry is doing any biological research at all, that is research on the resource.

The Chairman: But let us say on equipment?

Dr. Needler: I think their research on processing and equipment is rather limited; it is more what you would call quality control.

Senator Robichaud: That is right.

The Chairman: They are studying plant efficiency.

Dr. Hayes: Yes, in some industrial plants and this sort of thing, time and motion studies of employees and I suppose this is a kind of industrial research.

Dr. Needler: They have considerable people with engineering training in the industry; there is quite a large number engaged in that type of activity.

The Chairman: Now when we come to patents on page 42 I think it is the board that says that the Board is not in the business of inventing things which can be patented.

This looks to me a little surprising especially when we look at the description of at least one sector of your research programme dealing with commercial products. On page 21 regarding the research you do, it states:

> Collaborating with the industry to operate existing fishery products, developing or improving handling and preservation processes, the determining factors of the first quality, developing new products from fish—

And so on. Is there not a field, at least in that sector, of research which should normally lead to patents?

Dr. Hayes: The only reason we would take out a patent I think would be to prevent some private individual from moving in on his own and patenting a board discovery from which he might make some money, but in general anything we discover about improved processing is published and becomes public property.

The Chairman: But even if it were to be licensed on a free basis in Canada, perhaps if there was a patent taken we could get some money from abroad.

Dr. Hayes: We have done a few of these which are listed on page 134, but the number is not large.

The Chairman: But you do not seem to be really interested in this.

Dr. Hayes: We have not pushed it very much, no. We do not employ very large numbers of engineers in the Board. They are employed more in other agencies of the department and I suppose processes in plants, and so on, perhaps come out of the engineer type of thinking.

I suppose that if we did hit on something corresponding to the addition of vitamins to milk and so on, which was a Wisconsin University affair, we might patent it. But we have not been thinking along those lines.

Senator Bourget: Does the same thing exist in, let us say, the United States or the USSR, or any other countries regarding patents? They do not patent very often?

Dr. Hayes: I do not know that this is true, no, I do not think this is the usual thing in this area.

Senator Bourget: So it is given to the industry?

Dr. Hayes: Yes.

Senator Bourget: To use.

Senator Robichaud: Are there not, in effect, certain machines, like filleting machines and skinning machines, which have been patented and cannot be used freely by the industry?

I am thinking of one in particular, the Bader machine? I believe it is a German-made machine.

The Chairman: Surely other countries must try to patent their technological discoveries in the field of new machinery and new equipment for fishing. If we do not do the same here, perhaps we have not made the discoveries, I do not know, but if we do make some discoveries then we give this free of charge of other countries?

Dr. Hayes: We are at present, for example, in our Dartmouth laboratory, working toward a fish counting apparatus that will enable populations to be censused in a very much more effective way than the present sort of echo sounder business.

I am sure if we developed that we would take a patent on it.

The Chairman: Is the same policy followed by the department?

Dr. Needler: We have patented one or two, more than that, but some are new designs of fishing gear.

I think that this is a very open question, Mr. Chairman one might ask, for example, should we have patented the fish protein concentrate process that was developed at Halifax.

The Chairman: You have no answer?

Dr. Needler: I have no firm answer on this.

The Chairman: Is this used widely?

Dr. Needler: It is not yet used widely, but it is a basis for a number of plants that are now being planned.

The Chairman: And would it be susceptible to use in other countries?

Dr. Needler: Yes.

Dr. Hayes: Yes.

Dr. Needler: One can prevent patent by publication of description of a process of that kind. My understanding is that once this process has been described in a scientific publication, it becomes impossible for anybody else to patent exactly that.

The Chairman: Are you sure of that, because when a publication in scientific journals is public property it seems to me it belongs to nobody.

Dr. Needler: I believe that prior publication of this sort prevents patenting; I am not a lawyer in this field.

The Chairman: Oh, prevents patenting?

Dr. Needler: Yes.

The Chairman: But in those cases it seems to me that the publication of the article could wait a little bit.

Dr. Hayes: Perhaps we should have patented our fish protein concentrate. I have never thought of it until this minute. One assumes that this is a benefit to the industry and hopes that the Canadian industry will make use of it.

The Chairman: I do not think that this procedure should be applied in order to prevent technological development in Canada, but at least if these processes or new products or new equipment are used in other countries, at least we should get some money out of it, because I am sure that if we used some German equipment here we would pay for it.

So I assume that you will give some thought to this aspect of the problem.

Dr. Needler: I would think so, yes; it would be interesting to have your committee's views on this eventually.

The Chairman: I suppose that our views would be very clear: if you have a chance to make money out of our research discoveries here, especially from other countries, I am sure you will have our blessing. Our views, I think, are fairly simple.

Now I would like to ask a question in relation to the composition of the executive committee. On page 4 you say that the executive committee consists of representatives of the regional advisory committees, the chairman and the deputy minister as an ex-officio member. How many of these representatives of the regional advisory committees are on the executive committee?

Dr. Favre: There are three regional committees on the board there are at the present time besides the chairman of the board six members.

The Chairman: You have six members who represent the regional advisory committees?

Dr. Favre: Yes.

The Chairman: Then the chairman and the deputy minister?

Dr. Favre: Yes, the deputy minister.

The Chairman: The chairman as an ex-officio member?

Dr. Favre: Yes, and we have six members.

The Chairman: Two from each of the three committees?

Dr. Favre: Yes.

The Chairman: But if this executive committee establishes as you say the national priorities in terms of your research programmes it means that the full board does not have very much to say about these national priorities.

Dr. Favre: If I may, Mr. Chairman, answer this question: I think you are touching the most vital point of our activities as a council. We have to establish priorities and in order to do that about three years ago we initiated a ten-year plan so that we can now when we have a new programme or a new project definitely know how this will fit into the general planning.

It is evidently a matter of making a decision, therefore I think we are taking into account the various aspects, the practical aspects, economic aspects, the urgency of the research to be done, if it is for immediate preference or if it is long-range planning. Then I think we take everything into consideration, and we do our best, but I must say that the entire process is not quite satisfactory, because we went as far as we could by making a ten-year plan, but in order for this plan to be workable so that it becomes useful it has to be inserted into a more general planning and this cannot be done I think by the Board itself. This general planning would be, in my opinion, a 25-year plan and this is exactly what I think we do expect: a more general body, which is definitely inter-disciplinary and which would come from all parts of Canada, to be established.

At the present time I do not really think that the various organizations are quite useful. I mean the Science Council, the Science Secretariat, the Arts Council, because with fisheries I think you have to deal with people and individuals; there are some social aspects you definitely have to take into consideration when you are establishing priorities.

The Economic Council; I mean, it is quite obvious that now in Canada you need some more planning to be done, but not the type of planning I think everyone can do. I mean a prolongation of what is going on right now. When you prepare a ten-year plan that is exactly what you do; we are doing this and now we can anticipate that within the next three or four years the science will become say more involved in that aspect or another aspect.

So everyone can do that, but the real planning is science in itself and this is exactly what Canada needs; it is a body really establishing major priorities and establishing these on a really scientific basis.

The Chairman: Thank you very much, but to come back to our specific case here, I understood you to say this morning that the Board was meeting usually once a year?

Dr. Hayes: Yes. What does the board do? That is your question?

The Chairman: The Board would very likely then devote most of its time at that meeting to distributing the money allocated to universities?

Dr. Hayes: No, I do not think that this would be quite the function of the Board. I think the Board itself would determine large matters of policy. For example, if we were going to move, as we did, a laboratory from London, Ontario, to Winnipeg, Manitoba, or move from the waterfront at St. John's Newfoundland, to the campus of St. John's, this would be a matter for review and debate in the full Board and the full Board does deal with large matters of that kind, but the full Board does not deal with the allotment of specific sums of money to this or that project. So it is really that one tries to get national policies discussed in the full Board and the financial expedition of these handled by the Executive.

The Chairman: So that the Board does not really have very much to say in terms of the actual content of your research department?

Dr. Hayes: Not very much, no. The Board spent some time last January, for example, debating the conditions under which they might allow university professors and their students to set up a summer establishment in St. Andrews adjacent to our Board laboratory buildings and whether we could deal with one university or a consortium, or what the circumstances would be. This is where we can draw on the combined wisdom of people from a number of agencies.

The Chairman: But insofar as the research programme itself is concerned, the executive committee is the main body?

Dr. Hayes: In deciding on programmes finally, yes.

The Chairman: On priorities?

Dr. Hayes: The Board members, of course, are each members of one of the regional committees and in that capacity, yes, that is true; the Board as a whole does not examine all individual research programmes.

The Chairman: Do all individual projects come before this Executive Committee?

Dr. Hayes: No, this is a function really of size. The Executive Committee meets for a couple of days and smaller matters, small amounts of money or projects do not reach it necessarily.

The Advisory Committee reports are presented to it and they will plan the course for

the next year. When a project is continuing it may not come up for annual review.

Usually if there is any new programme or change in direction it will come before the Executive.

The Chairman: They meet for two days; do you mean each time they meet?

Dr. Hayes: Yes, one or two days.

The Chairman: How many times a year?

Dr. Hayes: Twice; one or two days, once at the time of the annual meeting, and usually once when we have a target from the Treasury Board, in September or thereabouts.

The Executive on its part has delegated to a part of itself, its academic members are called the Personnel Sub-Committee and they deal with the employment of the scientists and their promotions, and so on.

The Chairman: How many people from industry are on this Executive Committee at present?

Dr. Favre: Two.

The Chairman: Two out of eight?

Dr. Favre: Yes.

The Chairman: I notice also that throughout the reports there was some complaint, and I am sure that this is well justified, about the difficulty of changing the mentality and attitude of fishermen towards technological improvements and all this.

Do you have some kind of education programme, or do you make any special effort to change these mentalities and attitudes?

Dr. Needler: The Department, Mr. Chairman, has an information service and part of its function is to prepare material in popular form for broad distribution. I think, however, one of the more effective ways of introducing new methods to fishermen is demonstration and demonstration is a part of the activities of the Undustrial Development Service.

It is sometimes difficult to say when experiment stops and demonstration begins, but demonstration is definitely a part of it. Sometimes this is demonstration not of something that is discovered in Canada, but demonstration of a technique from a distance. For example, we brought a Japanese to Newfoundland to demonstrate more efficient ways of catching squid and it was not long before the Newfoundlanders adopted these, in spite of their traditional tendencies.

The Chairman: Are you giving any thought to organizing a service for fishermen like the Department of Agriculture wants to organize, a kind of computer system to help farmers in their management and all this?

I am sure you are aware of that programme which is going to be launched fairly soon, I think.

I do not remember exactly the name of that programme; perhaps some of the members remember it?

Dr. Needler: This is Business Management, is it?

The Chairman: No, a programme whereby, providing that the farmers will give information about their business, then they will tell them what kind of mistakes they are making in their management.

Dr. Needler: We have not done that yet, but it might be a very good thing to do. I think we should look into it.

Senator Robichaud: Is the department not gathering data regarding the types of gear, different types of boats, the total earnings, depreciation, etc.? Such information is being gathered now, is it not?

Dr. Needler: Yes, and this gets a fairly wide distribution. This is an analysis of the costs of fishing operations, and the returns.

The Chairman: But what the Department of Agriculture has in mind is much more elaborate than this.

Dr. Hayes: Yes; this is probably a weakness, I think, in all sciences; we do not have enough of what I call GP's, who can take scientific discoveries and apply them to the case in hand. This is a difficult type of man to recruit, who has this kind of ability and I am sure that a great deal more must be done.

The Chairman: Are you trying to develop this kind of service so as to be able to convince fishermen to better adapt to change, because this way you can have the nicest research programmes and then we produce researchers who are more and more frustrated because their discoveries are not applied by the industry.

Dr. Needler: I think, Mr. Chairman, that demonstrations and the contact with our field staff have led actually to fairly rapid changes in fishing methods on a number of occasions.

The Chairman: Have you made any studies of how the process of technological diffusion is developing among fishermen? We were told, for instance, that among farmers one of the best methods of diffusion is from one dynamic farmer to others. Have you made any studies about the way fishermen react?

Mr. W. C. MacKenzie: No scientific studies, Mr. Chairman, but this is a common observation of anyone who has close contact with fishermen and the fishing industry.

The Chairman: Because it seems to me that this should be some kind of vital operation for the department, in the sense that you cannot pursue all these research programmes in isolation then just realize a few years later that the fishermen are not using it.

Mr. MacKenzie: I think also, Mr. Chairman, that one could anticipate that the developments that were described this morning toward creating a more elite group among fishermen, men who had a stronger stake in the fishing operations because they, in a sense, were given a quasi-property right, the limitation of entry, and this sort of thing would lead also to a greater interest in the application of scientific discoveries.

The traditional fisherman, as you probably know very well, operates by tradition. Their approach to their business is often described as a way of life rather than as an industry; it is a significant term.

Dr. Needler: Mr. Chairman, I would like to make two remarks, if I might: one of them is that I think that the conservation of the fisherman is sometimes exaggerated. I think that if one or two fishermen, and this corroborates your former statement, if one or two fishermen make a success of a new method of fishing, a lot of people follow very quickly.

Senator Robichaud: Crab fishing.

Dr. Needler: I was going to mention crab fishing. A few people had a profitable experience in the crab fishery in one year and one year later I think that in Senator Robichaud's home county maybe almost half of the people who had been engaged in dragging for ground fish switched to the crab fishing, financed it themselves, did it on their own initiative. So the fishermen are really not that conservative and they do react to success by one of themselves. If the government does something they are very prone to say oh, well, it costs a lot of money and that is not really a demonstration. So I think this is true.

I would like, however, to make a general observation which I think agrees with what you have been saying. Whereas it seems to me that in agriculture there is in this country everything from research, fundamental research, applied research, demonstrations through illustration stations. There are many agricultural agents who I think in the main are employed by the provinces, who are generalists, or as Dr. Hayes says, the general practitioners, and a large number of experts in particular things to whom they can refer, who are mainly federal.

In the fishing industry, on the fisheries scene I think we are weakest in this body of field workers who are generalists; we try to use our own field staff in this way but we do have the responsibilities for law enforcement and inspection and so forth, and this is actually a hindrance as far as those individuals are concerned in this educational function. So that our field staff for this purpose in such places as the industrial development service is really very limited and in fisheries the provinces have not put as many people in this field as is the case in agriculture.

So that I think we actually are rather weak in our field work among fishermen, to be sure that they are aware of opportunities of various kinds, not merely scientific, but technical, engineering, even economic.

The Chairman: I have two unfair questions to ask, to finish: I want to come back to pollution. Now then, Senator Grosart is back, and I am sure that he will join me perhaps in this question.

Senator Grosart: I am only back, Mr. Chairman, because I was ruled out of order by the Speaker.

The Chairman: So you can make your speech here. I am glad that you have warned me. It seems to me that in this whole field of pollution we have been, in the federal field, in a state of almost complete confusion. This might be completely unfair, but this is the impression that a lot of members of this committee have developed as a result of our hearings. We have, for instance, three different categories of agencies, some dealing with safeguards and seeing that these are implemented. We have research agencies like yours. Then we have, I understand, at the federal level only one control agency, which is your department.

Do you not think that at some stage we will have to think of organizing a much more integrated organization than this, both in terms of finding safeguards and of doing research in relation to pollution? Is that an unfair question?

Dr. Hayes: No, not at all. I think there are a great many agencies. I have heard it said there are over 100 agencies in Canada which had some sort of authority to do something about pollution.

Senator Grosart: We have been told there are 228.

The Chairman: No, we are not dealing now with municipalities, provincial governments and international organizations; we are just dealing with the federal government.

Dr. Hayes: The federal government's rights are somewhat limited and I suppose that it would be very difficult to get the provinces to agree to strengthen federal acts.

I do not know what kind of results would come from a proposal that the federal government be given additional powers, but I suspect that it would be quite a job to get the provinces to surrender any real authority to the federal government.

So, if this idea is correct, then we are stuck with our present legal rights to enter the field and we have got to stretch them to the limit.

The Chairman: Yes, but as you were saying this morning, at least if we can ensure that the fish will survive, perhaps we have a good chance to see humans survive, too.

So you have an agency of control there at the federal level.

Dr. Hayes: We have an agency of control which will have to be tested in the courts, certainly.

I think another of the troubles in pollution is that the municipalities have been under the belief that if they take human excrement and break it up and then put it in that it is somehow less deleterious and less likely to fertilize the pond than if they put it in raw.

This may be artistically better, but the same amount of phosphate and nitrate goes in. So that what we really have to look for is some way to prevent the phosphate and nitrate going in, not the question of whether it goes in in lumps of chopped up.

I think this is something for the municipalities and cities to get educated on and this is where the biologists have made virtually no impact and this is the biologist's business, to understand the business of raising fertility of lakes to an undesirable level and I think he does know what some of these problems are; he does not know all the cures, but his advice is not being widely followed.

There is also the question of separating; if you want to prevent the contents of the sewers going in it has got to be separated in a storm sewer or else every rain storm will flood it over; this is what they have been doing in Ottawa now, and this is a very expensive business of tearing up all those streets to get storm sewers. The country has not altogether been willing to face this kind of cost. This is thinking about a budget perhaps of the order of cost of national defence.

Perhaps one of the worst possible uses of research is to say we do not propose to meet our budget, so we say let us have ten years research and buy off the FRB with a few million dollars, which will not cost anything, instead of doing something about the problems which we know, such as separating the storm sewers from the domestic sewage.

Facing up to the costs is one thing; facing up to the biologists' views about the nature of phosphate and nitrate and what form it is in and making no difference to the effect of pollution is another.

When some of these things are done I think perhaps we can handle our water problems, but there is a lot of education to come in the meantime, I am sure.

The Chairman: And better integration of our research effort within the federal government at least.

Dr. Needler: I think, Mr. Chairman, some progress is taking place in that. The unfairness of your question, if there is any, and I do not think it is really unfair, is asking one ministry to give an opinion which includes the operations of others, but I think that this co-ordination of research activities regarding pollution is proceeding and I think that the situation is improving as far as this is concerned.

The Chairman: It must have been pretty bad.

Dr. Needler: I think it was.

The Chairman: Do you have any questions in relation to this, Senator Grosart?

Senator Grosart: I do not have a specific question. I would like however to express again my concern about the necessity of moving from co-ordination, or alleged co-ordination to control in this matter. I would ask if anybody has any idea how we can get some kind of control, even in the limited area of research. We have asked other departments about it, for example, the co-ordination of their grants to universities for projects that they let out. In my reading of the submission on this question of projects, am I correct in recalling that you have had 22 over a period of five years?

Dr. Hayes: Contracts.

Senator Grosart: Yes, contracts; that is research projects that you have let out, 22 over five years, and I believe your statement says it is distributed more or less equally between universities and industry.

Dr. Hayes: Yes. They are listed on page 131; they are listed from 1962 to 1968. I should say that these are not the university support programmes at the present times; these are contracts for getting specific work done, which might have been done in the board by our own staff, but which it is more convenient sometimes to have done at a university or somewhere else. For example, the Department of Nutritive Science and Food Science or whatever they call it, in Toronto, has been working up the nutritive value of Canadian fishery products. We could do that in any of our labs, but they are equipped to do it and it is a more efficient way to get it done.

I would call this contract board work which we have done outside, as distinct from our university grants, which are grants for research in universities.

Senator Grosart: Limiting my question just to research and to the universities: my impression is that various departments make science policy decisions to give a grant to a university for a particular purpose, or to let out a research project to a university and that there is little or no co-ordination between the various science policy decision-makers in the departments. The reason I say that my impression is that there is little or no co-ordination is that the end result is that indicated to us by the Science Council, that we are in a complete imbalance today in our whole division of research, R and D between industrial, government in-house and university.

The Science Council says we are in complete imbalance; this has to be the result of a lot of bad decisions, not necessarily a bad decision on the part of any one department, but cumulatively bad decisions. Now, what is being done to prevent this? You gave us an example with the Burlington situation, where you had eight universities all trying to be centres of excellence in the same field.

The Chairman: That was given more specifically by the Department of Energy, Mines and Resources yesterday afternoon.

Senator Grosart: I am sorry. You are working us too hard, Mr. Chairman, and I cannot remember which department this comes from. But is there any mechanism—I do not mean any hope or good intention—but is there any mechanism in this one field, because if there is a mechanism in this field, maybe we can get it somewhere else? In this one small field, is there any mechanism to prevent this kind of imbalance that we have achieved over some years of bad cumulative science policy decision making? Is there anything going on?

Dr. Hayes: Usually the complaint about the imbalance ends up when one comes to give an example by saying that there is too much money being spent on nuclear physics in relation to biology or renewable resources. I think this particular thing, which is the one that everybody cites, is due to just a couple of policies. The National Research Council has said that they support the man rather than the subject and that if the man is bright they will support him. The wartime effort to get the Chalk River establishment going generated a whole bunch of young fellows in the area of nuclear physics and they all went to universities and are producing students.

This momentum has carried this thing on till now and everybody is getting concerned about it.

As of now the federal government, we know for example, will support any areas of science in the universities that are relevant to renewable natural resources in the area of this field that we are interested in and so on, but you still have an agency like the National Research Council which does not make these distinctions, or has not been making these distinctions, and so the people apply and if they are bright I suppose they will get the support.

But certainly the so-called mission-oriented groups, if they had the distribution of the money and the federal government were saying we want this kind of emphasis given in our federal agencies like the Fisheries Research Board, one to two, five to seven, or whatever the relevant sums of money are, and we want each of these groups to support a university programme to some percentage of its total, say 10% or something, then this would automatically reflect the areas of support in the universities and there is a lot to be said for that. This is what we are trying to do in our area.

Of course, the levels of support, for reasons that I do not always altogether understand, in the renewable natural resources, fisheries, forests and agriculture, have simply been in the joke column compared with what is available in other branches of science. I do not know why that is so, but it is very difficult to get it rectified.

Senator Grosart: That is exactly the point I am making. Could I ask this specific question: let us say you decide, when you are making up your budget for next year, that you will put so much R and D into five universities. Have you any information available to you at that time about what the other 40 people who are putting research money into universities are doing, what universities, what disciplines?

Dr. Hayes: We do not officially receive this information.

Senator Grosart: You are making a more or less isolated decision.

Dr. Hayes: That is correct.

Senator Grosart: I am sure you are not happy with that.

Dr. Hayes: No; I think it would be useful to know what is happening elsewhere. I would envisage a national system, under which the Secretariat handled all these and the various mission-oriented agencies had a right to nominate up to a certain level within their own area of science.

Senator Grosart: Would you not agree that this might well be one important function of a Ministry of Science Policy?

You mentioned the Science Council, you mentioned the Science Secretariat; they do not seem to have very much influence in such cases as ING and the B.C. telescope, ING particularly, where both the Science Council and the Secretariat provided thick reports, approving ING in the most glowing terms. Yet the government decided otherwise.

I am not criticizing or questioning the government's decision; I am merely concerned with the fact that these two bodies give advice and it it not taken. I think the reason is that there is no responsible Ministry to co-ordinate. The Science Secretariat might be looked on in a way as a ministry; and you might even say the same about the Science Council, but in neither case is there a Minister with the responsibility of looking over the whole expenditure, the whole direction of the expenditure of public funds in research.

Would you agree with me that this might be one of the functions of a Ministry of Science Policy?

I emphasize the word "Policy" to get over the objection that you indicate; I think you said, sir, that you would not agree with a certain kind of Science ministry.

The Chairman: I think you are still confused, Senator.

Senator Grosart: Am I?

The Chairman: Yes.

Senator Grosart: Still in the wrong pew?

The Chairman: Because I do not think that this question was raised at all by our guests of today; this was raised in the brief of the Department of Energy, Mines and Resources yesterday afternoon.

Senator Grosart: Anyway, I can still ask the question.

Dr. Hayes: Professor Favre is outside the government service and has some opinions on science policy in Canada and on a Ministry of Science possibly, what it might or might not do; he may have a comment to make on your question.

The Chairman: We will definitely have to adjourn at 5:30 and I still have one brief question, so if you can limit your answer to about five minutes, we could go ahead. I suppose that there are no other questions?

Otherwise the alternative, Senator Grosart, might be to ask Professor Favre to give us a more elaborate answer to this question in writing, if that is satisfactory.

Senator Grosart: I was just interested in getting an opinion from our witnesses as to whether they saw any kind of function for a Science Policy Ministry.

The Chairman: I think it is a very complicated subject, as you very well know and if Professor Favre does want to deal with it now, that is up to him.

Dr. Favre: I think, Mr. Chairman, I could try in a few minutes to give you what I think about these various matters.

Just a few minutes ago I referred to a 25-year plan; therefore, if the Minister of the Science Policy Department you are referring to is in charge of planning and of establishing the 25-years plan, I think I would agree that it is exactly what we need, because I do believe that it is general fact now all over the world that science has grown at a tremendous rate and no one knows what to do with it. So there is a new science emerging now, the science of science, and in Canada at the moment I think we are facing this very problem.

I do not think that the Science Council is the answer to that, because it must be interdisciplinary. Therefore, it must be above the economic council, the arts council and the science council.

Now, it would be wrong in my opinion, I believe, to have a department which would concentrate all the research being done within the government laboratories into one huge organization. I think the research is progressing because of interactions between research people. The point is I think it would be wrong to expect too much really from a research organization, a huge research organization, because the important point is not to do research, it is to find something and I think there is a human problem in that.

It is really a psychological problem and all these aspects have to be put into one picture.

To me the important problem we are facing in Canada is the following: we are investing great sums of money into research. We are supposed, in doing so, to eliminate the cost of error, and by eliminating the cost of error we are supposed to eliminate the cost of uncertainty. I do believe that the situation is such that we are not really eliminating the cost of error and we are not eliminating the cost of uncertainty.

Everyone is puzzled about what is going on and the answer I think is really to have one man in charge of the operation. I think there are various sytems to be established and it is not really profitable in the few minutes' time left to me to discuss the various possibilities, but there are very many systems.

The French, the English, the United States they have been tried and they are not too successful. Why? Because I think in this very special field of planning we have not invested enough money in research, therefore I think we do not know exactly what the outcome will be, but there is one sure thing, we have to do something, and if I may come back to the question you asked a few minutes ago about pollution, I think the government has to do something about pollution, and again I think it is the job of one man to really do something.

I think you can form a committee to investigate what has to be done, but when you reach the point of doing things the committee is no longer working, or a set of committees I think is even worse. I think you need just one man and one man who is really responsible and everyone will know that this man is responsible.

I think as far as the Fisheries Research Board is concerned, our interest is only in the biological aspect, therefore when we come to do this we have a body of scientists and we are the only ones in Canada, the only organization which can really contribute this body of scientists and this amount of knowledge gained from many, many years of outstanding research.

It must be inter-disciplinary, because pollution is not a simple problem, but in order to do inter-disciplinary research I think you need one man.

The Chairman: Thank you very much, Professor Favre. I do hope that if you have time, I know you are very busy, but if you have time, you will perhaps put in writing a more elaborate answer on this problem, because I think it would be very useful, I am sure, to the Committee.

Professor Favre: I would be very pleased to do so.

The Chairman: We would be very pleased to receive it.

A final question to Dr. Needler: what will you do, sir, if you receive a request from the forestry part of your operation to establish a forest research board as the fishery people have now?

Dr. Needler: Mr. Chairman you said if I received such a request; I would say that I would look upon the request with a great deal of sympathy and try to move in that direction.

I feel that the Fisheries Research Board's system has worked very well; the Canadian fisheries research is very good compared with other countries. I think also that the research in the forestry branch is very good and their present set-up has worked quite well, but using your question exactly the way it was asked, if such a request should come I think that it would be considered extremely favourably. I think that even if the request does not come we will be more or less forced by circumstances to give some consideration to the organization of research in forestry.

The Chairman: I never thought that you would go that far; thank you very much.

Senator Robichaud: May I take this opportunity to express our appreciation to both the Deputy Minister, Dr. Needler and to the Chairman of the Board, Dr. Hayes, for submitting their presentation this morning, their summary, in our two official languages, both in French and in English.

The Chairman: Thank you very much indeed; it has been a very useful day for us.

The committee adjourned.

APPENDIX 15

Summary Remarks on
Presentation of Department of
Fisheries Section,
Science Policy Submission
by
Dr. A. W. H. Needler, Deputy Minister

In its internal structure, the Department of Fisheries has five distinct services which apply scientific knowledge and procedures in implementing fundamental departmental objectives. These services are concerned, respectively, with resource development, fish inspection and quality control, industrial development, economic research and international fisheries commitments.

Two of these services, Resource Development and Inspection, deploy their staff predominantly in field locations, as required by the nature of their responsibilities. Two others, Industrial Development and Economics, employ specialists who undertake continuing and ad hoc investigations whenever and wherever required. The International Fisheries Service, which has a minimum staff, relies for scientific backing upon the Fisheries Research Board and, on occasion, appropriate services of the Department.

Co-ordination of programs undertaken by the various services is effected by consultation at local, regional and headquarters levels among program managers and service directors. At intervals, program review exercises subject current programs to critical scrutiny in order to assess their effectiveness and to determine priorities.

While expansion of funds available for proposed programs would be welcomed, a chronic shortage of professional staff is regarded as perhaps the outstanding hindrance encountered by the Department in the pursuit of its objectives. Among measures taken to encourage recruitment, the most effective has been the summer employment of university undergraduates.

Looking into the future, scientific endeavours in which the Department is involved may be expected to follow recent trends for at least the next five years, but there is reason to believe that these efforts will be intensified thereafter. Greater pressure may be put upon fisheries resources to sustain a significantly expanded recreational fishery. Because of the regional character of the fisheries, the contribution by the Department's activities toward regional development in Canada promises to remain substantial.

RESOURCE DEVELOPMENT

The Resource Development Service is organized to combat man-made and natural pressures upon fishery resources and where possible to effect environmental improvement. This service deploys professional and technical staff at regional and field locations across the country. The professional staff of 95 positions (84 occupied) includes 58 biologists and 26 engineers; in addition, seasonal work is provided for an average of 65 university students.

Principal objectives of the service are: to maintain and expand stocks of fish and shellfish by application of scientific and technical means, and to advise on fishery management techniques. Programs for protection and expansion of fishery resources, control of water pollution, and resource investigation and management are carried out in close cooperation with other government agencies, industrial firms and international organizations.

Examples of achievements by the service are: effluent-treatment facilities developed to protect Fraser River salmon stocks from pulpmill pollution in British Columbia; the world's largest Atlantic salmon hatchery constructed to preserve salmon in the St. John River in New Brunswick, development of oyster hatchery facilities, Prince Edward Island; operation of a sea lamprey control program to permit fisheries rehabilitation in the Great Lakes; a major stream-flow-control

and spawning-channel project to augment salmon stocks at Babine Lake, British Columbia; and modifications adopted in chemical forest spray programs in order to minimize harm to fish.

In the area of resource management, a wide range of studies and investigations is undertaken to broaden knowledge of fish stocks, especially salmon on Pacific and Atlantic coasts, so as to improve management techniques.

While public demand is expected to increase in future for an expansion of fishery resources, both for food consumption and for recreational fishing, these resources will be subject to formidable pressures from industrial and other competition for water use. To meet this challenge, new or improved scientific techniques will be required such as, for example, the artificial propagation of salmon—currently a very promising concept—and implementation of the transplant technique as applied in efforts to establish Pacific salmon in Great Lakes and Atlantic waters, and Atlantic lobsters on the coast of British Columbia.

INSPECTION SERVICE

Although a relative newcomer in the application of the scientific approach to regulatory responsibilities, the Inspection Service has gained wide recognition for the thoroughness with which it has organized a systematic quality control and inspection program on behalf of the Canadian fishing industry and the consuming public.

This Service was established as a departmental unit in 1949. Its main objectives are to implement a program of fish inspection to protect the health of the consumer, and to create consumer confidence by maintenance of high quality standards. Related activities include the conduct of applied and developmental investigations on fish handling, processing and storage problems; demonstration of quality control processes, techniques and equipment; and development of new fishery products.

The staff of the Inspection Service is deployed in the five administrative regions of the department. Professional positions currently total 104, of which 20 are vacant and six are filled by non-professionals. Serving professionals include 41 food technologists, 17 bacteriologists, 13 chemists and 7 engineers. Under a current program to upgrade educational standards, 19 non-professional inspectors are currently enrolled in university degree courses. Seasonal duties normally provide summer employment for 10 student assistants.

Emphasis in the service's approach in recent years has been re-directed from policing the end-product toward the promotion of quality control procedures and sanitary environmental conditions.

A chain of federal Fish Inspection laboratories has been established across Canada to carry out scientific testing of fish and fish products. In recent years, vacancies in field staff have been filled by science graduates who undergo in-service training as Fish Quality Specialists. Most recently, an engineering section has been introduced to round out the corps of professionals required to set and apply appropriate quality standards and to provide technical and scientific advice to the industry. This qualified staff is also being utilized to conduct applied research in efforts to solve specific problems of the industry.

Close collaboration is maintained between the Inspection Service and other government and international agencies which are concerned with food quality, and with the fishing industry itself.

Among technical accomplishments to which the service has contributed may be mentioned: development of an optical instrumentation system for colour evaluation of canned salmon and tuna; an improved fishing vessel refrigeration system; a new and improved system for highway transport of frozen foods; use of super-chilling techniques to preserve the quality of fish fillets; and improved handling and processing methods associated with the development of Queen crab and Greenland turbot fishing enterprises.

Further evolution of scientific methods of fish inspection are anticipated in the next five years, accompanied by broadening of applied research and development activities.

ECONOMICS SERVICE

The Economics Service concerns itself with the economic factors in the management of fishery resources and in regional development. This service relies for basic data upon field staff units, but concentrates its research personnel at headquarters for maximum efficiency and flexibility. Seventeen profes-

sional positions, two of them currently vacant, comprise the research unit. No significant changes in the establishment are foreseen during the next five years.

The objectives of the service relate to the department's requirements for economic guidance in formulating policy. Studies conducted in fulfillment of this role pertain to the efficiency of the industry at all levels of production, the relative importance of the commercial and recreational fisheries, and the impact upon the industry of domestic and world demand for fish and fish products.

In the performance of these duties, liaison is maintained with other government agencies, all segments of the fishing industry, provincial fisheries administrations, international bodies such as FAO and OECD, as well as government sources in the United States and other countries.

To supplement its own endeavours, the Economics Service utilizes the assistance and co-operation of universities and consulting services. Investigations undertaken by the service within the last five years include: an annual cost-and-earnings study of the Atlantic fishing fleets; rationalization studies of particular fisheries: Pacific salmon, Atlantic lobster, Newfoundland groundfish, Northwest Territories; and benefit-cost studies of the Great Lakes lamprey control and Newfoundland household resettlement programs. Most significant among these projects have been those associated with the control of entry into commercial fisheries for west coast salmon and east coast lobster.

Some reorganization of the service is considered desirable in order to give adequate attention to such matters as sport fisheries and the impact of further technological changes upon the various phases of the industry.

INDUSTRIAL DEVELOPMENT SERVICE

The Industrial Development Service was established in 1955 to foster modernization of the commercial fishing industry. Since 1960 this service has actively demonstrated and promoted technical improvement and innovation, particularly among segments of the industry whose progress was retarded by outmoded methods and equipment. Cost-sharing programs undertaken with the provinces and continuing consultation through federal-provincial fisheries committees have given strong impetus to these endeavours.

Primary objectives of the service are: expanding and modernizing the commercial fishing industry, increasing productivity, improving skills and techniques, and effecting greater diversification of fishing activity.

A reorganization of the service approved by Treasury Board in the current year provides for an eventual establishment of 75 persons, including a substantial proportion of professional and technical personnel. Three branches are envisaged, having responsibility in the areas of Fishing Operations, Exploratory Fishing and Vessel and Engineering activities.

The services of outside specialists and consultants are utilized to carry out a portion of the programs initiated by the service. National and international conferences dealing with fisheries technology and related matters are attended by staff members in order to keep abreast of significant developments, and the service itself has handled arrangements for similar conferences sponsored by the Federal-Provincial Atlantic Fisheries Committee.

Among major contributions by the service to the fishing industry and the community in general are: fostering of an Atlantic herring industry which has tripled in value of catch within five years; development of the Irish Moss industry in Prince Edward Island and the Queen crab fishery in the Atlantic coast provinces; development of a mid-water trawling technique to help boost catches of herring and other pelagic fish stocks; improved mechanical drying equipment for salt fish production; improved trawling techniques applied in more than doubling smelt production in Lake Erie.

A reduced dependence by industry upon technical assistance from the service is anticipated in future as industry modernization progresses, thereby permitting greater attention to be given to long-term investigations aimed at improved exploitation of offshore fishery stocks.

INTERNATIONAL FISHERIES SERVICE

Compilation and analysis of scientific data on behalf of ten international fisheries commissions and councils in which Canada holds membership is a responsibility of the Interna-

tional Fisheries Service. Canada is represented on each of these organizations by a senior official of the Department of Fisheries. The actual scientific research required by these commitments is undertaken on behalf of the Fisheries Ministry by the Fisheries Research Board or, on occasion, by the Resource Development Service.

The nine Commissions referred to deal with fisheries of the Northwest Atlantic, Great Lakes, international whaling, North Pacific fisheries, North Pacific fur seals, Pacific halibut, Pacific salmon, Atlantic tuna, and tropical tuna. The tenth organization which was mentioned is the International Council for the Exploration of the Seas.

APPENDIX 16

SUBMISSION OF THE MINISTRY OF FISHERIES

TO THE

SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

PART I: INTRODUCTION

DECEMBER
1968

SUBMISSION OF THE MINISTRY OF FISHERIES

TO THE

SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

PART I: INTRODUCTION

December, 1968
OTTAWA

MINISTRY OF FISHERIES

INTRODUCTION

The Ministry of Fisheries is concerned with the conservation and enhancement of Canada's commercial and sport fisheries. The responsibility is broad, involving the fitness of the aquatic environment, the living resources of salt and fresh water, and the food and natural products removed therefrom for utilization by man. The benefits are both economic and social.

The economic importance of Canada's commercial fisheries is demonstrated by the annual harvest of more than 1,250,000 tons of fish and shellfish, which have a landed value of approximately $150,000,000, and a processed value of about double that amount. Both the quantity and the value of this production are increasing, but not at a rate sufficient to maintain Canada's position among the major fishing nations of the world. Between 1957 and 1967, Canada dropped from 7th to 10th place in the volume of her landings. Nevertheless, Canada remains one of the world's four largest exporters of fish ($219,000,000 in 1966, mainly to hard currency countries, with $150,000,000 to the United States). By comparison, the value of fish exports was only $136,000,000 in 1957 when Canada stood first among exporting nations. The fisheries resource therefore makes a substantial contribution to Canada's economy as a whole and to her export trade. Yet it cannot be ignored that Canada is facing increasing competition at sea -- even at her own doorstep, and her products are facing increasing competition on domestic and foreign markets.

The social importance of the Canadian fisheries resource is indicated by the large number of persons deriving all or part of their income from the commercial fishing operations (over 80,000) and from the processing of the product (about 20,000). The fact that these numbers should be and, in many important areas, are being reduced, can be expected to improve the efficiency of the industry from the standpoint of benefit/cost to the national economy and hence improve Canada's competitive

position in relation to other nations. Such actions, of course, must be integrated with those of other agencies of government more directly concerned with regional economic and social welfare.

A less tangible, but perhaps even more significant benefit accruing from the fisheries resource, is the rapidly growing outdoor recreational opportunity which it affords to Canadians and visitors alike. While experts in economics have long sought to develop a rational method of evaluating the worth of sport fisheries, a concensus has not yet been achieved. Furthermore, it may be that if, as predicted, the demand for recreational opportunities continues to grow at the continuously accelerating pace of recent years, the public might not be prepared to accept monetary evaluations which are based solely on the cold realism of economics.

The Ministry is deeply concerned about the biological aspects of aquatic pollution. Many commercial fisheries are jeopardized by this deplorable manifestation of man's thoughtlessness. Quite apart from economic consequences, water itself is a vital resource for recreation. Clean water for fish means clean water for man. Thus problems of fisheries are inseparable from those of pollution, and control or eradication of aquatic pollution unquestionably has many tangible benefits.

Exclusive legislative authority for "Sea Coast and Inland Fisheries" has been conferred upon the Parliament of Canada by Head 12, Section 91, of the British North America Act, and the functions and powers of the Minister of Fisheries stem principally from this document.

Since the passage of this Act, however, responsibility for some freshwater fisheries has been delegated to the Provinces because of their local nature and their interrelationship with recreation and tourism; but the Federal Government, through the Ministry of Fisheries, retains responsibility for administration of some inland fisheries and, except for Quebec, for all sea fisheries. Sea fisheries, which frequently are the cause of serious international problems, comprise over 95 per cent of the nation's fisheries production, and represent more than 90 per cent of its value.

The Ministry of Fisheries is the instrument by which the government's policies are discharged today, and it exists pursuant to the Department of Fisheries Act, R.S.C. 1952, Chapter 69, which allocates to the Minister of Fisheries such duties, powers, and functions as may be designated or assigned by the Governor-in-Council. The Minister has the administration of several acts, all or parts of which concern scientific research or the application of the results of such research: The Fisheries Research Board Act, R.S.C. 1952, Chapter 21, the Fisheries Act, R.S.C. 1952, Chapter 119, The Fish Inspection Act, R.S.C. 1952, Chapter 118 and the Fisheries Development Act, Chapter 18, 14-15 Elizabeth II. In addition, there are several acts pertaining to the Ministry's involvement in international fisheries conventions.

Underlying the enabling legislation of the Fisheries Ministry, is the fact that, with only a few minor exceptions, the nation's fisheries and those of international waters are renewable common-property resources which can be effectively administered, developed and protected only by application of all available scientific and technical knowledge.

Responsibility for the application of this highly specialized expertise cannot logically be assigned to the private sector because the fruits of any such endeavours might well be harvested by competitors. Furthermore, the Canadian fishing industry, as a whole, is so fragmented that it has neither the means nor the capability. Accordingly, this responsibility has devolved upon government.

The Ministry of Fisheries is the only Federal agency in Canada which is directly concerned with the application of science in all matters relating to the fisheries resource. With this capability, the Ministry therefore is in a position where it performs an important co-ordinating role, not only with other federal agencies but also with other fisheries administrations in the provinces, largely by means of Federal-Provincial committees at the Deputy Ministerial level.

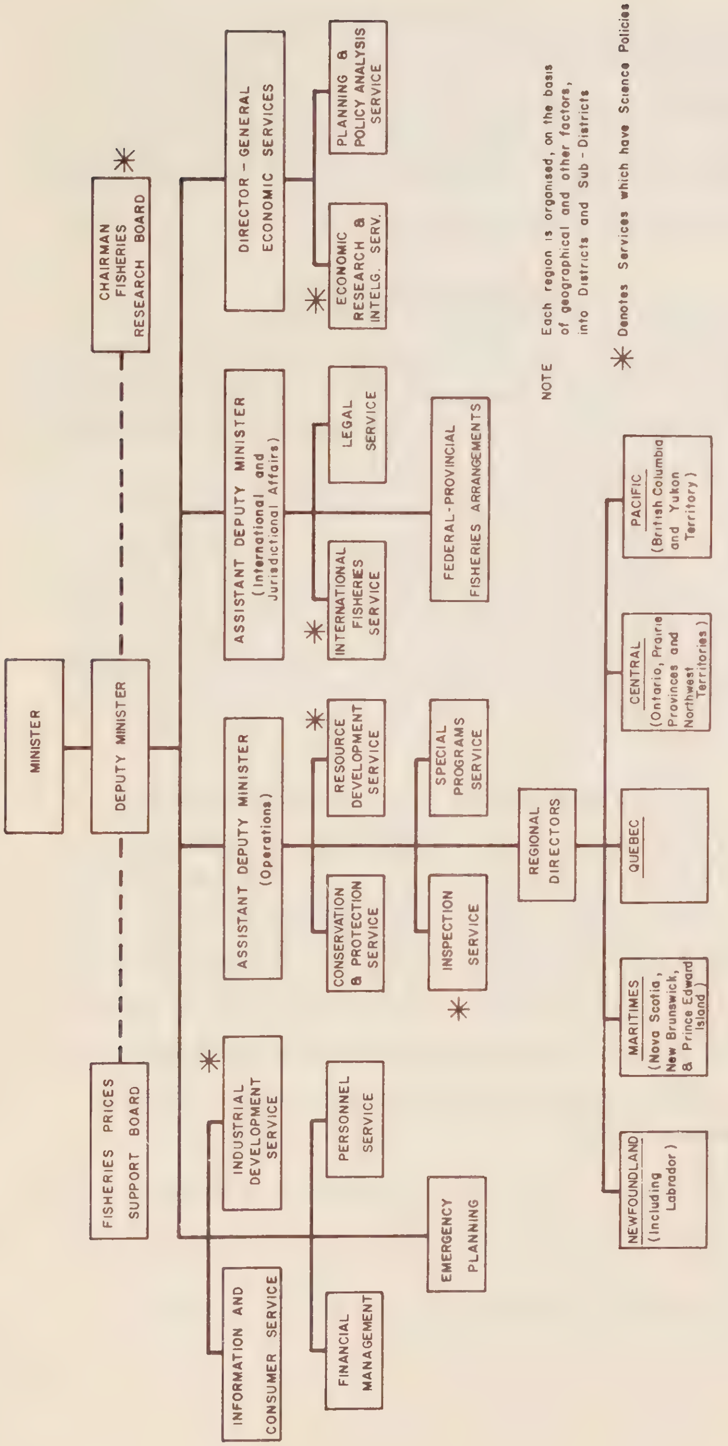
The Ministry's basic policies may be reduced to the generalization that it endeavours to do whatever is necessary in the interests of the Canadian people and the national economy insofar as these may be influenced by the commerical, sport, and native subsistence fisheries.

Elaboration of this fundamental concept logically leads to the following basic objectives of the Ministry:

- to maintain the yields, to the Canadian commerical and sport fisheries, from stocks of fish, shellfish, and marine mammals, by regulating their exploitation; and to prevent damage to the resource by other uses of water or by the fisheries of other nations;
- to increase, wherever feasible, the existing yields of fish, shellfish, and marine mammals by application of scientific management principles and fish cultural techniques, and by environmental improvements;
- to improve the efficiency of the industry, or reduce its operational costs, by undertaking explorations for currently unknown stocks which might be exploited profitably; by developing, testing, and demonstrating to the industry, new fishing methods, gear and techniques; and by providing expert advice on all matters concerning the availability of the resource and the effectiveness of existing and new harvesting techniques;
- to maintain, by means of regulations and expert advice to the industry, consistently high quality products which command the confidence of domestic and foreign consumers;

Fulfillment of these objectives can be achieved only through the continuous application of all available knowledge concerning the resource and its environment, the industry itself, and the demands of domestic and export markets; by continuously improving this knowledge through the pursuit of vigorous and imaginative research programs; and by assuring that activities of the Ministry are fully coordinated for greatest economic yield to Canada.

The accompanying chart outlines the internal structure of the Fisheries Ministry, designating (*) the principal organizational units which, in the context of the Special Committee's Order of



ORGANIZATION CHART – DEPARTMENT OF FISHERIES
(JUNE, 1968)

Reference, apply science policies. Each of these units whose functions are described briefly hereunder, has evolved from the Ministry's responsibility for the administration of the several acts mentioned above. The current consolidation of Fisheries and Forestry in one Department may affect the overall organization, but it will not affect the scientific needs of these activities.

I. THE FISHERIES RESEARCH BOARD

The Fisheries Research Board is an agency of the Ministry having the primary and predominant responsibility for scientific research within the Ministry. It conducts research on marine and freshwater fish, their environments and their fisheries. It is also charged with the responsibility for determining the best ways and means of utilizing the fisheries resources which includes product research, engineering and other technological investigations. The Board's scientific programs are mission-oriented and associated with the Ministy's objectives outlined above. They bring the research to the point of application either by the fishing industry or by the various Services of the Department of Fisheries.

The Board collaborates actively with the various Services of the Department of Fisheries in the discharge of their responsibilities. For example, FRB provides scientific direction and technical support of projects of interest to the Industrial Development Service, or scientific support of projects undertaken by the Resource Development Service.

The Board assumes a major responsibility for the scientific support of the International Fisheries Service of the Department which is involved in international fisheries commissions, negotiation of new conventions, etc.

THE DEPARTMENT OF FISHERIES

Under the Fisheries Act, R.S.C. 1952, Chapter 119, as amended, Statutory functions and powers regarding scientific activities are not mentioned in detail. However, they are inherent in the powers and duties which this basic statute confers, particularly those set out in sections 4, 20, 24, 28, 33, 34, 48, 50, 56, 57 and 62.

Within the Department of Fisheries there are five Services which are involved in the application of scientific knowledge collected by the Fisheries Research Board, by the Services themselves, and from many other sources, often from outside Canada.

(a) The Industrial Development Service is dedicated to improving fishing techniques and equipment, and to bringing new resources into use. This Service (either by itself, or in cooperation with provincial fisheries agencies on a cost-sharing basis) conducts explorations for commercially valuable stocks of fish, tests and demonstrates new fishing methods (either imported from other parts of the world, or developed by its own staff), and makes available to the fishing industry the advice of experts from all over the world.

(b) The Resource Development Service applies scientific and technical measures for the purpose of maintaining or developing Canada's freshwater and inshore marine environment and its living resources. It collaborates with FRB, or, in certain areas not covered by FRB research, may engage in investigations required for practical application and assist in the provision of scientific advice on fisheries management.

(c) The Inspection Service is responsible for the certification for human consumption of fish and fishery products destined for domestic and foreign markets; for the practical application of research on new fishery products of commercial

importance; and for application of knowledge required for solution of problems encountered in the handling, processing and distribution of fishery products.

(d) The Economics Service undertakes economic research, including collection and analysis of statistical data, on all aspects of the fisheries resource in order to provide market and other economic intelligence to the fishing industry, governments, and the public.

(e) The International Fisheries Service is responsible for Canada's obligations in respect to the nine international fisheries commissions and one international council to which she belongs. Through these organizations Canada cooperates with many other nations in the conduct of research and its application to the maintenance of living aquatic resources and the management of fisheries of mutual interest.

III. PLAN OF PRESENTATION

The brief on the scientific functions, activities and policies of the Ministry's Fisheries Research Board appears as Part II of this submission. The involvements of the Department of Fisheries' five services, insofar as science is concerned, are presented in Part III.

APPENDIX 17

SUBMISSION OF THE MINISTRY OF FISHERIES

TO THE

SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

PART III: DEPARTMENT OF FISHERIES OF CANADA

DECEMBER
1968

SUBMISSION OF THE MINISTRY OF FISHERIES

TO THE

SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

PART III: DEPARTMENT OF FISHERIES OF CANADA

December, 1968
OTTAWA

The internal structure of the Department of Fisheries is organized into units (Services), and each of those which undertake scientific activities, in the context of the Special Committee's Order of Reference, bears responsibility for the pursuit of at least one of the basic Departmental objectives.

The Industrial Development Service is concerned with modernization of the commercial fishing operations, looking to increasing the efficiency and profits of the industry; the Resource Development Service is responsible for the maintenance and expansion of the fisheries resource through the application of scientific principles; the Inspection Service is dedicated to the quality improvement of fish and fish products; and the Economics Service undertakes economic research and intelligence functions on behalf of other Services, other arms of government, and the general public.

The local and continuing nature of the programs of the Resource Development Service and of the Inspection Service has resulted in the deployment of most of their respective staffs to the Department's administrative regions (Pacific, Central, Quebec, Maritimes, and Newfoundland), with functional direction being provided by a small senior staff located at the Directorate headquarters in Ottawa. On the other hand, the programs of the Industrial Development Service and of the Economics Service's research division are more specific, and their personnel are therefore located principally in Ottawa, where they constitute pools of experts which may be drawn upon to resolve urgent problems as they arise anywhere in Canada.

While each Service has a specific role to fulfill, they do not operate in isolation from each other. In fact, a close rapport exists between them, largely because of frequent staff meetings, at the national, regional, and district levels,

which are attended by appropriate representatives from all Services for the purpose of discussing and reporting on current programs. Such meetings, convened, say, bi-monthly, tend to foster better understanding of the aims and endeavours of others, promoting a more cohesive effort toward fulfillment of Departmental objectives.

Of course, there are almost-daily contacts of a more informal character as well, and whenever joint programs are undertaken they usually are planned and directed by intra-departmental committees, or task forces, consisting of representatives of the Services which are directly involved.

Inasmuch as each Service has been organized for the specific purpose of meeting one of the Department's several basic, but diverse objectives, their individual policies are not identical because each has had to implement some procedures which best suit their own particular needs. Nevertheless, the Services have much in common, and this report has been prepared to outline their common policies at the outset, followed by detailed explanations of the discrete policies and achievements of the individual Services.

The operational effectiveness of the programs of all Services, and, indeed, of their individual sub-units, is reviewed at intervals, and revised as deemed advisable, by means of the Department's annual program-review exercise; by staff meetings convened at all levels, as required; by application of the superior-subordinate concept throughout the range of the Departmental hierarchy; and by project reports.

Insofar as the basic Departmental objectives are concerned, the program-review exercise is, perhaps, the most useful tool for measuring effectiveness and determining priorities because it provides the means whereby all of the Department's programs are subjected to critical review, not only at Headquarters but also within the Regions, in order to determine the order of

priorities with respect to programs, staff, and funds. Throughout the course of this exercise, program managers are afforded the opportunity to defend their past, present, and future activities; and to offer constructive criticisms of the programs of other Services. Competition for the dollars allocated to the Department is therefore keen, and, through the process of elimination and/or curtailment, priorities emerge.

Assessments of the benefits accruing from individual projects undertaken by the Department frequently cannot be finite, simply because of the vagaries of the fisheries resource. For instance, projects undertaken for the purpose of expanding the living resource cannot be appraised rationally until the expiry of at least one life cycle of the species involved, and this could encompass several years. Moreover, the indicated success (or otherwise) of such projects could be totally erroneous, particularly if it is based solely on one life cycle, inasmuch as there are many extraneous factors which can cause profound fluctuations in fish population densities from generation to generation.

Human nature, being what it is, inevitably leads program managers to conclude that they have insufficient funds to perform their essential functions. In most instances, however, what the program manager really means is that he does not have enough money to do all of the things that should be done, or that he would like to do. Nevertheless, he is obliged to allocate priorities on the strength of the funds allotted to him, and, in this way, the really deserving programs are pursued, while marginal ones are deferred or abandoned. In this sense, then, it cannot be said that the magnitude of the funds allotted to the Department constitute a hindrance to the pursuit of its objectives.

On the other hand, it should be noted that the Department could effectively utilize a substantial boost in funds in order to undertake many worthwhile projects which have had to be deferred, at least temporarily, because of the prevailing financial climate.

DEPARTMENT OF FISHERIES

EXPENDITURES (ACTUAL AND FORECAST), BY ACTIVITY, FOR SCIENTIFIC ACTIVITIES DURING THE FISCAL YEARS 1962-63 TO 1968-69 INCLUSIVE

($000)

Activity	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Resource Development							
Operations	458	501	557	617	794	985	1087
Capital	212	151	131	449	544	605	887
Total	670	652	688	1066	1338	1590	1974
Inspection							
Operations	508	537	576	610	678	756	829
Capital	42	34	18	64	41	55	50
Total	550	571	594	674	719	811	879
Industrial Development							
Operations	542	533	1067	2129	2778	3014	2672
Capital	14	1	30	159	165	22	9
Total	556	534	1097	2288	2943	3036	2681
Economics							
Operations	120	129	143	154	213	246	281
Capital	-	-	-	-	-	-	-
Total	120	129	143	154	213	246	281
Administration							
Operations	155	158	174	181	225	246	282
Capital	1	1	1	1	-	-	4
Total	156	159	175	182	225	246	286
Total - Operations	1783	1858	2517	3691	4688	5247	5151
Capital	269	187	180	673	750	682	950
Grand Total	2052	2045	2697	4364	5438	5929	6101

The long-standing shortage of competent professional staff is, perhaps, the outstanding hindrance encountered by the Department in the pursuit of its objectives. It should be noted, however, that this situation apparently does not stem solely from the pay structure inasmuch as industry, which usually has a free rein in such matters, is also experiencing recruitment problems. Competition for the most able scientific personnel is therefore extremely keen.

In its efforts to recruit competent scientific personnel, the Department works closely with the Public Service Commission, to the extent that it participates in personnel interviews, rating boards, and cross-Canada recruitment drives, visiting various university campuses and technological institutes with a view to "selling" the concept of a Departmental career to promising upcoming graduates.

While these steps have been reasonably effective, more success has been attained by hiring graduates who, during the course of their undergraduate years, have worked with the Department as summer students. Such individuals usually are extremely valuable acquisitions because they have had the opportunity, through the course of their temporary employment, to decide whether or not permanent employment within the Department is to their individual liking. Moreover, the knowledge acquired during the summer recesses is decidedly to the advantage of the individual and the employer.

On the other hand, the prospective employer is in a position where he has some considerable knowledge of the strengths, weaknesses, and capabilities of those who have previously been engaged on a part-time basis, and he is able to select those who appear to offer the most promise. For these reasons, the Department strongly supports the policy of hiring undergraduates during the summer season, and would employ an even greater number if more funds could be made available.

The Department's competitive position might be strengthened if prospective recruits, or perhaps more properly, the most promising ones, could be assured of sound career growth patterns. Moreover, the services of some highly qualified personnel might be retained if the Department were given reasonable latitude to pay its scientific personnel according to their worth. In this connection, a promising individual who has reached the top salary level of his position may be forced to leave government service for financial reasons only, because his job is rigidly classified, and openings for more senior positions are currently non-existent - yet, the man's supervisors may feel that, because of his exceptional talents, he is worth far more to the organization than what he is currently being paid.

The conservativism of certain segments of the fishing industry, and their frequently unreasonable tendency to resist change, is another hindrance which the Department encounters. Similarly, provincial fisheries administrations are sometimes reluctant to cooperate in matters of mutual concern.

While it is anticipated that the scientific endeavours of the Department will follow recent trends for at least the next five years, there is reason to believe that these efforts will be intensified as the capabilities of individuals, particularly those who have joined the Department only in relatively recent times, continue to develop.

It is expected also that continuation of the current trend, whereby the general public is being afforded continuously more leisure time, will place additional pressure on the fisheries resource as a major form of recreation, and that the substantial effort which is currently being expended on the sport fishery resource will be intensified significantly in the near future.

The role of the fisheries resource with respect to the development of regional economies may be described as one which ranges from dominance to insignificance, depending upon the selected locale. It is noteworthy, however, that all Provinces and both Territories derive revenue from commercial fishing operations, as well as from sport fisheries and the tourism which they generate.

In the Atlantic provinces, exploitation of valuable stocks of Atlantic salmon, oysters, lobsters, cod, haddock, and myriad other species has long been a major factor in the economy of the region. Indeed, it may be said also that Pacific salmon, halibut, herring, and other fish and shellfish have made a substantial contribution to the development of the British Columbia economy; and although their percentage-wise contribution to the latter has been diminishing in recent years because of the heavy influx of other industries, they retain their vital importance in the provincial economy, particularly insofar as it relates to remote coastal settlements and the native Indians.

While the significance of the fisheries resources of the provinces of Quebec and Ontario have been overshadowed by other developments, they nevertheless are of importance to the economies of both. In Quebec, the residents of the Magdalen Islands and the Gaspé peninsula are particularly dependent upon the fisheries resource for their livelihoods, as are substantial numbers of Ontario residents who fish the Canadian Great Lakes and other waters.

Contrary to popular belief, even the Prairie Provinces have significant commercial fisheries for whitefish, lake trout, pickerel, and other species, the bulk of which finds its way into United States markets. These fisheries are of particular significance from the socio-economic viewpoint because of the employment opportunities they afford to native Indians and Metis who reside in areas where there are few other means of support.

The fisheries resource in the Yukon Territory is relatively unimportant to the economy, although it has made a small contribution. On the other hand, it is of great importance in the Northwest Territories, particularly in the Great Slave Lake region and along the western shores of Hudson Bay. Here again, the resource is of particular significance to the Indian and Eskimo populations.

While the commercial fisheries tend to receive first consideration whenever the economics of the resource are mentioned, the recreational worth and its contribution to the tourist industry might well be greater than that of the commercial operations. In this connection, the fact that many anglers, in addition to their local weekend expeditions, are prepared to travel thousands of miles and spend many hundreds, even thousands of dollars to land an Atlantic salmon, Arctic char, lake trout, Pacific salmon, or other species serves as an indicator of the value of the resource, exclusive of its more intangible worth as a recreational therapy.

The Atlantic provinces and British Columbia are the broad geographical regions in which the application of scientific knowledge offers the greatest promise, simply because of their proximity to the vast fisheries treasures of the oceans.

DEPARTMENT OF FISHERIES

EXPENDITURES (ACTUAL AND FORECAST), BY REGION, FOR SCIENTIFIC ACTIVITIES DURING THE FISCAL YEARS 1962-63 TO 1968-69 INCLUSIVE

($000)

	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Headquarters							
Operations	605	607	1077	1990	2593	2832	2578
Capital	29	12	35	168	179	61	70
Total	634	619	1112	2158	2772	2893	2648
Newfoundland							
Operations	187	199	238	300	376	432	449
Capital	40	28	24	86	100	106	149
Total	227	227	262	386	476	538	598
Maritimes							
Operations	413	436	517	642	791	903	940
Capital	74	55	46	164	182	191	269
Total	487	491	563	806	973	1094	1209
Quebec							
Operations	51	53	58	61	69	76	85
Capital	4	4	1	6	4	5	4
Total	55	57	59	67	73	81	89
Central							
Operations	144	153	167	178	213	246	273
Capital	28	20	15	54	60	69	95
Total	172	173	182	232	273	315	368
Pacific							
Operations	383	410	460	520	646	758	826
Capital	94	68	59	195	225	250	363
Total	477	478	519	715	871	1008	1189
Department - Operations	1783	1858	2517	3691	4688	5247	5151
Capital	269	187	180	673	750	682	950
Total	2052	2045	2697	4364	5438	5929	6101

The Department's contribution to regional development has been, and will continue to be substantial. In this connection, one may cite the following concepts which are being applied: modernization of the industry, as a whole, in order to maintain or enhance its position in the face of ever-increasing competition; rationalization of the commercial fishing operations with a view to making them more productive in terms of expended effort; improvement of the quality of fish and fish products, looking to increasing consumption; and expansion of the fisheries resource with a view to increasing the nation's production. All of these programs make substantial, but often non-definitive contributions to regional economies, particularly with respect to many small communities throughout the nation which are heavily dependent upon the resource.

Not to be overlooked either is the defensive role played by the Department with respect to the prevention of fisheries losses stemming from outside influences. For instance, if no action was taken to combat pollution, some valuable stocks of fish, particularly salmon and trout, might well be decimated or eradicated; but the fact that the Department has been able to maintain many such stocks has indirectly contributed to regional economies, simply because such measures have been instrumental in preventing declines.

Programs may originate at the headquarters level or within the Regions, but in either case, both are closely associated with the detailed planning for their implementation; and, as deemed advisable, representatives of industry, provincial fisheries administrations, and other interested parties may be consulted beforehand to determine the possible impact which the proposed program might have on their interests.

On the other hand, project proposals usually are spawned within the Regions, where the Department's field staff are in close contact with the local situations, so that they are in a much stronger position to assess the needs for such projects and their prospective benefits. In practice, proposals which have the approval of the Region are forwarded to Headquarters in the annual program-review submission. If they then are accepted by the appropriate Service Directorate, they are passed along to the Program Review Committee, a triumvirate of senior Departmental officials, which determines priorities on the basis of assessments of benefit-cost relationships, socio-economic considerations, regional needs, technical feasibility, and other related factors. If the proposal survives this last step, detailed arrangements for its implementation are initiated.

Some projects, and, indeed, some programs relating to the expansion and development of the resource sometimes have to be deferred, despite their obvious benefits, because of an urgent need to defend against losses stemming from natural phenomena, man's activities, and other causes.

While network analysis methods have been employed as a tool for planning and monitoring programs and projects, their use has been restricted mostly to unusually intricate undertakings such as major construction projects and large national and international conferences arranged by the Department.

Consultants from the private sector are engaged whenever a particular requisite expertise is not available within the Ministry, and at those times when the manpower requirements of specific projects exceed that which the Department is able to provide.

DEPARTMENT OF FISHERIES

EXPENDITURES (ACTUAL AND FORECAST), BY DISCIPLINE, FOR SCIENTIFIC ACTIVITIES DURING THE FISCAL YEAR 1962-63 TO 1968-69, INCLUSIVE

($000)

Discipline	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Bacteriology	118	122	128	144	155	177	192
Biology	489	478	506	763	956	1130	1397
Chemistry	59	61	64	72	78	87	96
Economics	119	127	140	151	206	236	271
Engineering	432	424	578	991	1249	1366	1421
Fishing Technology	291	280	563	1159	1490	1540	1366
Food Technology	318	330	345	388	421	473	517
Naval Architecture	64	62	124	254	326	336	299
Sociology	38	36	73	153	196	202	178
Statistics	19	20	22	23	32	37	42
Administration	105	105	154	266	329	345	322
Total	2052	2045	2697	4364	5438	5929	6101

During the monitoring process, certain programs and projects naturally come under critical review, and, ultimately, some may be discontinued or abandoned in order to devote attention to others which offer more promise. Such action stems principally from the changes wrought by the passage of time, and the fact that, within the confinements of the available budget, funds which were originally allocated to such activities in the light of the then-current exigencies might offer greater prospective rewards if applied to other programs or projects which have been conceived or developed in the interim. Departmental managers are therefore schooled in the principle that they must be prepared to adapt to the changing times.

They are also encouraged to utilize all available means to transfer the knowledge acquired as a result of their endeavours to those who seemingly would benefit thereby. In this connection, annual reports, progress reports, and project reports are distributed widely to the fishing industry, within appropriate scientific circles, and to interested individuals. Moreover, key personnel from industry and other agencies frequently are invited to attend seminars and lectures which are deemed to be of especial interest to them; and they are also extended specific invitations to inspect laboratories, projects, and other Departmental undertakings whenever it would seem to be of benefit for them to do so. The Department's personnel also contribute papers and articles to scientific journals, trade magazines, and other literary media. Similarly, they frequently are interviewed by the press, and make appearances on radio and television; and they often are called upon to address industry groups, service clubs, recreational organizations, and other such bodies.

Conferences, convened for the purpose of exchanging information with counterparts from elsewhere in Canada, or, indeed, from other nations, provide an excellent avenue for the transmittal of scientific knowledge; and, in addition to acting as a sponsor for some conferences, ranging up to the international level, the Department encourages its scientific personnel to attend and participate in those sponsored by others. Scientific personnel are also encouraged to exchange information with individuals of other agencies by means of informal visits and correspondence.

Promising scientific personnel are also urged to further their educational credits up to and beyond the Bachelor level, consistent with the feasibility of their being able to take a protracted leave of absence. Financial support, of varying degrees, depending upon the individual and the circumstances, may be provided from government funds.

In this connection, the funds expended by the Department to further the professional education of its staff during the period 1962-63 to 1968-69 inclusive, have been $5,000 in each of the first three years, $6,000 in 1965-66, $95,000 in 1966-67, $104,000 in 1967-68, and $95,000 provided for 1968-69.

Within the Department's own capabilities, deserving employees receive instruction from senior Departmental personnel, and by means of seminars, on-the-job training courses, secondments to undertake special assignments at various locations, including Departmental headquarters, and other means as the opportunities present themselves. Moreover, scientific staff at all levels, are being enrolled in the administrative courses sponsored by the Public Service Commission.

Distinctions have not been drawn between research administrators and researchers, as such, although scientific administrative positions tend to be more senior, and advancement of an individual to a relatively senior level usually is therefore dependent to a considerable degree, upon his administrative, as well as his scientific abilities. This combined talent is generally discovered in an individual by his supervisors who endeavour to foster its development by assigning successively increasing responsibilities to the individual, and continuously monitoring his progress.

Having outlined some of the broad basic policies of the Department, as they apply to all units, this report will now direct attention toward the policies which have evolved within each Service in order to meet their specific individual needs.

RESOURCE DEVELOPMENT SERVICE

The Fisheries Act, which was passed in 1932 as the basic operational statute for the Department of Fisheries, contains provisions for the protection of the fisheries resource from the harmful effects of other water users.

In the immediately ensuing years, the problems associated with the implementation of this legislation were rather simple and straightforward, but, with the passage of time, they have become increasingly more complex, as a result of the burgeoning economy and the accompanying demands which it placed on the fish's environment.

Furthermore, the threat to the nation's most valuable fish stocks has been increasing steadily as a result of international exploitation of some stocks, increasing efficiencies of the commercial fishing operations, the rapidly expanding recreational demands of the general public, and the activities of other industries.

For these reasons, the Department, in 1949, re-organized the Resource Development Service, as it is known today, for the express purpose of applying scientific knowledge to combat these threats, and to undertake environmental improvements. Today, the Service employs biologists, engineers, fish culturists, technicians, and appropriate support personnel who are deployed across the nation.

The personnel establishment of the Resource Development Service currently stands at 95 professional positions in the biological and engineering disciplines. Eighty-four of these positions are occupied at the present time by incumbents whose academic qualifications are as follows: 38 biologists with Bachelor's degrees, 19 with Master's degrees, and one with a Ph.D; while the engineering section consists of 22 individuals with Bachelor's degrees and four with Master's. Ten of these individuals are devoting most of their time to administrative duties.

The average age of the Service's professional staff is 34 years. Five individuals are fully bilingual in Canada's two national languages; two claim partial qualifications with regard to speaking, reading, and writing of the French language; and 18 claim to be able to read French with reasonable facility.

The possessor of the Ph.D. obtained his doctorate in the United States 12 years ago, but he has been employed with this Department for only one year. Comparable data with respect to other staff members possessing lower degrees are set forth on the following pages.

Country	Birth	Secondary Education	University Education Bachelor	University Education Master
Canada	69	72	71	16
United Kingdom	3	2	3	-
United States	5	5	5	7
New Zealand	1	1	1	-
Australia	1	1	1	-
Poland	1	-	-	-
Austria	-	1	1	-
Rhodesia	1	1	1	-
China	1	-	-	-
Germany	1	-	-	-
Israel	1	1	1	-

TOTAL NUMBER ON STAFF

Year	Bachelor	Master	Ph.D.	Total
1962	30	5	-	35
1963	32	5	-	37
1964	34	4	-	38
1965	42	6	-	48
1966	52	8	-	60
1967	63	16	1	80
1968	61	22	1	84

NUMBER OF STAFF

Year	Bachelor Hired	Bachelor Released	Master Hired	Master Released
1962	5	3	-	1
1963	3	1	-	-
1964	3	1	1	1
1965	8	-	2	-
1966	11	2	1	-
1967	14	7	5	-

No. of Years	Bachelor Since Grad.	Bachelor With Dept.	Master Since Grad.	Master With Dept.
0	1	3	4	5
1	7	18	3	10
2	7	5	3	4
3	7	5	1	1
4	6	2	1	-
5	2	-	-	-
6	2	3	-	-
7	-	-	2	-
8	4	3	-	-
9	2	1	1	1
10	3	6	-	-
11	4	4	2	-
12	-	1	2	-
14	1	1	-	1
15	2	2	-	-
16	1	1	1	-
17	1	-	2	-
18	1	1	-	-
19	8	4	-	-
20	1	1	-	-
26	1	-	-	-

The employment histories of the current professional staff with Bachelor's degrees (Master's shown in brackets), expressed as a percentage of the total, has been: industry - 11.5 (nil); university faculty - 1 (1); provincial government - 3 (1); other Federal department - 8 (5); and international commissions - 7 (1).

One employee with a Bachelor's degree is currently absent from duty on educational leave for the purpose of acquiring a Master's degree.

The Service also makes extensive use of the services of university students, at various academic levels, who are engaged during the summer recesses under the provisions of the Public Service Act and Prevailing Rate Employees Regulations. During the course of the last seven years the average annual number so employed has been 65 students.

Only a small nucleus of professional staff is located at the Service headquarters, where it formulates national policies, monitors regional programs, and performs other related staff functions.

Branches of this Service are maintained in four of the Department's five administrative regions, the exception being the Quebec Region, where the fisheries resource is administered, by agreement, by the Province.

The individual programs of each of these units are the responsibility of the respective Regional Directors, who, in turn, exercise this responsibility through the Regional Chiefs of Resource Development.

While the activities of the four regional units are not identical because of varying local conditions and problems, they are bound together by the common objectives of the Service, which are:

- To develop and implement scientific and technical measures to maintain the physical and biological environment inhabited by stocks of fish and shellfish in a satisfactory condition for maximum production of these stocks.
- To develop and implement scientific and technical measures which will expand present stocks of fish and shellfish in Canada.
- To develop knowledge and provide scientific advice for the management of the fishery resource to allow maximum exploitation by commercial and recreational fisheries commensurate with requirements to perpetuate the resource.

In practice, attainment of these objectives is sought by means of four discrete activities: fisheries protection and expansion; water pollution control; resource investigation and management; and administration.

Pursuit of these activities necessarily involves close association with the Fisheries Research Board of Canada, which is responsible for all basic research undertaken within the Ministry; and, in fact, proposals which embody elements of both basic research and development of a fishery are being undertaken as joint projects.

Protection and expansion of the fisheries resource is regarded by the Service as a single activity because they frequently involve the application of scientific and technical knowledge which is common to both. The protection aspects of

this activity relate to the prevention of losses stemming from man-made causes and natural phenomena. In this connection, it must be borne in mind that fish are cold-blooded animals which are extremely sensitive to environmental changes. Accordingly, this activity is broad in scope, involving such projects as the provision of fish-passage facilities at rock slides, natural waterfalls, and other barriers; and habitat protection from pollution, log drives, seismic explorations, dredging operations, causeways, bridges, hydroelectric projects, flood-control dams, gravel removal operations, and land-use practices, such as clear-cut logging and mine waste disposal, which directly or indirectly, affect the aquatic environment.

Expansion techniques which are being applied by the Service are: the provision of access to barren, but potentially productive spawning and rearing areas in streams and rivers; the control of less desirable species which prey on or compete with valuable stocks of fish; the application of disease-control measures; the operation of fish hatcheries; and implementation of a comparatively recent, but promising environmental-improvement technique which involves the construction of new spawning beds, and artificial control of river flows, to create near-optimum spawning and rearing conditions. The latter was pioneered by the Service in connection with the propagation of Pacific salmon, and the technique is now being adopted and applied in the Atlantic provinces, as well as in the United States.

While water pollution control is essentially a form of the protection activity, it has been isolated therefrom because the inherent problems of the two are quite different.

Sections 33 and 34 of the Fisheries Act provide strong legislative powers which prohibit deleterious substances from being discharged into waters frequented by fish, and the Service therefore maintains highly qualified staffs of pollution-control experts who are responsible for the conduct of investigations to detect, assess, and prevent or abate pollution in fish-supporting waters.

The Resource Investigations and Management activity is primarily problem-oriented, and it has been developed for the particular purpose of providing a basic inventory of the extent and value of individual fisheries, and the potential productive capacities of the waters which they frequent. Information with respect to the routes and timing of fish migrations, intermingling of migratory stocks, spawning escapements and exploitation rates are developed and analyzed with a view to advancing recommendations for the formulation of regulations governing the exploitation of the resource.

Pursuit of the Service's basic activities frequently brings its personnel into close contact with other federal agencies, of which the following are representative:

- Frequent consultations are held with representatives of the Department of Energy, Mines, and Resources in connection with the fisheries aspects of certain multiple-water-use schemes such as flood-control projects and hydroelectric developments; and in the formulation of national pollution policies.

- A close liaison is maintained with the Department of Agriculture in connection with the control and use of agricultural sprays, and their possible impact on the fisheries resource.

The Service has worked closely with the Northern Canada Power Commission in connection with the provision of fish-protective facilities at the Commission's hydro-electric developments.

- The Department of Indian Affairs and Northern Development, including the Canadian Wildlife Service, is consulted with respect to problems of common concern.
- The Service cooperates with the former Department of Forestry and Rural Development to effect coordination of certain ARDA and FRED programs.
- The Atlantic Development Board is consulted by the Service in connection with fisheries studies as they relate to the activities of the Board.
- Contacts are maintained with representatives of the Department of National Health and Welfare in connection with pollution matters of mutual concern, including the pollution of shellfish growing areas.
- Working relationships are maintained with the Department of Public Works in matters relating to the dredging of rivers and harbours, and the possible impact of such operations on the fisheries resource.

The Service's contacts with industry are extremely diverse inasmuch as its personnel must have direct contact with the individual sponsors (public and private) of projects which may (or do) have a detrimental effect on the fisheries resource. Fulfillment of this responsibility therefore brings them into personal contact with senior scientific and executive personnel from industries such as pulp and paper, hydroelectric generation, manufacturing, and logging, as well as with those responsible for public works projects, but these contacts are too numerous to cite individually herein.

Canada's international commitments have given rise to the following typical involvements of the Resource Development Service:

- the operation of a sea-lamprey control unit, which is Canada's contribution to the Great Lakes Fishery Commission's objective to rid these waters of most of these parasites which have caused a serious decline in the valuable fish populations of the Great Lakes:

- the coordination of activities related to pollution and other water-use problems, and to the development of fish protective measures in the Fraser River, with those of the International Pacific Salmon Fisheries Commission, which, by treaty, administers the pink and sockeye salmon fisheries of this river system;

- participation in the activities of the Technical Sub-committee of the International Trawl Committee which coordinates the Canada-United States trawl fishing regulations, as they relate to certain Pacific Coast stocks;

- participation in the informal International Committee on Chinook and Coho Salmon which was created for the purpose of studying the harvesting of these stocks on the Pacific Coasts of the United States and Canada

- continuing guest participation at the meetings of the Pacific Marine Fisheries Commission which coordinates fisheries research programs on the U.S. Pacific Coast.

The Service actively participates in and contributes to international, national, and regional scientific conferences. For example, senior Service biologists have attended those of the International Council for Exploration of the Sea and those sponsored by the Fisheries Department of the United Nations' Food and Agricultural Organization. They also participate in the annual technical meetings of the American Fisheries Society, the Pacific Fishery Biologists Association, the Pacific Marine Fisheries Commission, the Canadian Committee on Freshwater Fisheries Research, and the Canadian Society of Wildlife and Fishery Biologists.

Engineers within the Service have actively participated in conferences convened by the Engineering Institute of Canada, the Northeast Wildlife Conference, and the International Association for Hydraulic Research, in addition to attending and participating in many of the foregoing biologists' meetings.

Pursuit of the Service's objectives with respect to the protection of the resource has given rise to a teamwork approach utilizing the combined knowledge of the biological and engineering disciplines; the former as it relates to the living resource, and the latter as it may be applied to assess and resolve problems confronting this resource. This melding of the two disciplines has been particularly successful not only with respect to the scientific activities themselves, but also in connection with the conduct of meetings and negotiations with industrial leaders who frequently are required to pay for fish-protective measures which are deemed to be necessary because of their endeavours.

While this teamwork concept has been effectively applied to resolve fisheries problems posed by other agencies and natural phenomena it has also been successful in connection with the Service's approach to expansion of the resource. For instance, coordinated application of the two disciplines has been particularly noteworthy in connection with the planning, construction, and operation of such major works as flow-control projects, artificial spawning channels, and salmon hatcheries.

To date, the impact of the Service's past activities is, perhaps, reflected most in the protective role which it has played, as exemplified by the following programs and projects:

- development of complex effluent-treatment facilities, in cooperation with the International Pacific Salmon Fisheries Commission, which render the effluents from several recently constructed pulp mills on the Fraser River, British Columbia, safe for fish, thereby making a substantial contribution to the preservation of the multi-million-dollar Fraser River salmon stocks, while still allowing development of the pulp and paper industry;
- design of the world's largest Atlantic salmon hatchery, which has only recently been constructed at the Mactaquac Hydroelectric Project on the Saint John River, New Brunswick, to ensure that this valuable stock will be perpetuated despite the construction of the necessary power development.
- participation in the rehabilitation of the mainland Maritimes oyster industry which has been struck by Malpeque disease; and the Service is currently developing, to the pilot-plant stage, an oyster hatchery which is showing considerable promise for future application in the interests of this important industry;

- operation of a sea-lamprey control program, to suppress these parasites in the Great Lakes, has reduced their populations to one-tenth of their former levels, thereby contributing to the rehabilitation of once-valuable commercial and sport fisheries.

Expansion of the resource is, perhaps, best exemplified by major stream-flow-control projects, coupled with artificial spawning channels, which have been constructed for the purpose of increasing the survival rates of young salmon in their fresh-water environment. The largest project of this type is currently underway at Babine Lake, B.C., and when this 8-million-dollar project is in full operation it is expected to contribute each year to the Skeena River fishery up to one million additional sockeye salmon.

In recent years, Service biologists associated with the scientific management of the fisheries resource have also become more deeply involved with their administration, and with the application of the concept that the catches of salmon migrating to discrete river systems might be increased in future by implementing regulations which will ensure that optimum numbers of the brood stock arrive on the spawning grounds. Furthermore, the management biologists assume an important role in the studies and negotiations relating to the fact that Canadian and United States fishermen frequently exploit fish stocks which are migrating to the waters of the foreign nation. They are also becoming increasingly more involved with the scientific management of Pacific herring stocks.

The magnitude and diversity of the Service's programs and projects, during the course of its comparatively short history, is illustrated by the titles of the following publications for which it has been responsible in whole or in part:

The Salmon Fishery in Nova Scotia. MacEachern and MacDonald. The Canadian Fish Culturist No. 31: 43 - 57.

Development of a Fast Growing Strain of Atlantic Salmon. Dalziel and Shillington. The Canadian Fish Culturist No. 30.

Fish Losses After Forest Spraying with Insecticides in New Brunswick, 1952-62, as shown by Caged Specimens and other Observations. Kerswill and Edwards. J. Fish. Res. Board. Canada, 24(4): 709-729.

Impact of Water Pollution on Fisheries in the Atlantic Provinces. Sprague and Ruggles. Canadian Fisheries Report No. 9: 11-16.

The Effect of Water Pollution on Maritimes Fisheries. C.P. Ruggles. Canadian Journal of Public Health 58(2): 77-79.

Methods of Evaluating Damage by New Brunswick Forest Spraying Programs to Salmon Fisheries. Elson and MacDonald. F. Res. Bd. Canada, Technical Report No. 6

A False Weir Fishtrap. K.H. Kupka. Can. Fish. Culturist No. 32

Return of Pink Salmon to Robertson Ck. shows promise of success. F.C. Boyd. Can. Fish. Culturist No. 32

An investigation of louvers as a method of guiding juvenile Pacific Salmon. Ruggles & Ryan. Can. Fish. Culturist No. 33

The effect of a marine seismic exploration on fish populations in British Columbia coastal waters. Kearns & Boyd. Can. Fish. Culturist No. 33

A device for injecting juvenile fish into a pressure conduit. Ryan. Can. Fish. Culturist No. 34

Fisheries problems associated with hydroelectric development. R.N. Gordon. Can. Fish. Culturist No. 35; Engineering Journal, October, 1964.

Juvenile sockeye studies in Owikeno Lake, B.C. C.P. Ruggles Can. Fish. Culturist No. 36.

The effect of flow control on freshwater survival of Chum, Coho and Chinook salmon in the Big Qualicum River. Lister & Walker. Can. Fish. Culturist No. 37.

A downstream migrant diversion screen. K.H. Kupka. Can. Fish. Culturist No. 37.

A field assessment of the effects of spraying a small coastal salmon stream with Phosphamidon. Schouwenburg & Jackson. Can. Fish. Culturist No. 37.

The role of the Department of Fisheries of Canada in dealing with problems presented by the use of pesticides in B.C. K. Jackson. Can. Fish. Culturist No. 37.

A technique for the enumeration of Chum salmon fry in the Fraser River, B.C. I.S. Todd. Can. Fish. Culturist No. 38.

Depth and Velocity as a Factor in stream rearing and production of juvenile coho salmon. C.P. Ruggles. Can. Fish. Culturist No. 38.

Studies on the early feeding of sockeye salmon alevins. L. Dill. Can. Fish. Culturist No. 39.

The effect of a marine seismic exploration on fish populations in B.C. Coastal waters. Journal of Can. Soc. of Exploration Geophysicists.

The Big Qualicum fisheries development project. Clay & Fahlman. B.C. Professional Engineer, Dec. 1962.

A re-assessment of Moricetown Falls as an obstruction to salmon migration. R.N. Palmer. June, 1964.

Fraser River chum salmon investigation 1963. I. Todd. Aug. 1964.

Notes on the Dutch method of computing water surface profiles at flood stages on the Rhine. C.H. Clay. Oct. 1964.

The fourth annual Johnstone Strait Report on the status of the even-year pink salmon stocks and of the chum salmon stocks of the Johnstone Strait study area and on the prospects for 1964. June, 1964.

Fisheries problems associated with the development of logging plans within the Morice River drainage. March 1964.

A progress summary of the Strait of Georgia Chinook and Coho investigation. Jan. 1965.

The Stikine River exploratory fishing program 1965. Crouter & Todd. 1965.

Proposed sockeye salmon development program for Babine Lake. April 1965.

Fraser River chum salmon investigation 1964. I. Todd. June, 1965.

Summaries of fisheries research on the pollution problem 1965. Department of Fisheries and others.

Summaries of research on the fish-power problem and related work, 1965 revision. Department of Fisheries and others.

The fifth annual report on the status of the odd-year pink salmon stocks and of the chum salmon stocks of the Johnstone Strait study area and on the prospects for 1965. May, 1965.

Big Qualicum River biological assessment studies. 1961-1962 Walker & Lister. Mar. 1965.

Owikeno Lake juvenile sockeye studies 1960-63. C.P. Ruggles. Mar. 1965.

Fraser River chum salmon investigation. Downstream migrant enumeration 1963-1964. I.S. Todd. Apr. 1965.

Resource Development in the Pacific Region. Report for 1966.

The 1966 Johnstone Strait report on the status of the even-year pink salmon and of the chum salmon stocks of the Johnstone Strait study area and of the prospects for 1966. Dept. of Fisheries. June 1966.

Skeena River salmon management committee Annual Report 1965 October 1966.

Salmon development techniques, their present status, and their possible applications to the British Columbia salmon stocks. Oct. 1966.

Effects of log driving on the salmon and trout populations in the Stellako River. Dept. of Fisheries & IPSFC 1966.

Fraser River chum salmon investigation 1965. R.N. Palmer. Aug. 1966.

The 1967 Johnstone Strait report on the status of the odd-year pink salmon stocks and of the chum salmon stocks of the Johnstone Strait study area, and of the prospects for 1967. R.N. Palmer. May, 1966.

Maintenance and development of the salmon resource. L. Edgeworth, B.C. Professional Engineer. March 1968.

Report on the fisheries problems associated with the proposed Stuart Lake storage dam. D. of F. & IPSFC. June, 1962.

Brief outlining the need for fish protective facilities at the Puntledge River hydroelectric development. March, 1962.

Puntledge River Inquiry Rebuttal by Department of Fisheries. March, 1962.

An assessment of the feasibility of converting Seymour-Belize Inlet into a freshwater sockeye producing basin. Department of Fisheries & F.R.B. July, 1962.

Fisheries problems associated with the development of logging plans within the Owikeno Lake drainage system. Feb. 1962.

Report on an inspection of tests of fish passage through turbines at the Shasta hydroelectric plant. K.C. Lucas. Nov. 7-8, 1962.

Report on a tour of fish facilities in the Republic of Ireland. C.H. Clay. Sept. 27-29, 1962.

Fraser River Chum salmon investigation, 1960. Jan. 1962.

Big Qualicum River Biological survey, 1960-61. Sept. 1962.

Report on an inspection of fish facilities in the Netherlands. C.H. Clay. 1963.

Final report of the Fraser River Board on the Flood Control and Hydroelectric power in the Fraser River Basin - Appendices. Sept. 1963.

Annual report to the salmon management committee on the status of the odd-year pink salmon stocks of the Johnstone Strait study area and on the prospects for 1963. July, 1963.

Fish Culture Development Branch, Pacific Area. Progress Report 1962. May, 1963.

Summaries of research on the fish-power problem and related work. 1963 revision. Department of Fisheries and others.

Fraser River chum salmon investigation 1962 downstream. migrant enumeration. Feb. 1963.

An assessment of salmon migration and the native food fishery at Moricetown Falls in 1966. R.N. Palmer. May, 1967.

Atlantic Salmon Investigation at Beechwood and Tobique Power Dam Fishways in 1963.

Salmon Tagging in the Saint John Area Weir Fishery. 1962.

Preliminary Account on Salmon Tagging in the Saint John Area Salmon Fishery. 1962.

Adult Salmon Distribution in the Saint John River System. 1964.

Annapolis River Fish Passage Studies 1960-1962.

Effects of D.D.T. and Phosphamidon on Caged Salmonid Fish in Central New Brunswick. 1962.

Effects of Forest Spraying on New Brunswick Salmon. 1964.

Preliminary Report on the Effects of the 1967 New Brunswick Forest Spraying on Juvenile Salmon and Their Food Organisms. 1967.

Some effects of Forest Spraying on Atlantic Salmon. J.R. MacDonald. 1967.

Representative projects undertaken by the Service in the last five years, including some which are now in progress, are described briefly hereunder.

Fisheries Protection & Expansion

1. The urgent need for a large reliable source of seed oysters in the Maritime provinces has resulted in the Service's implementation of a new hatchery technique which was developed by the Fisheries Research Board. In this connection, a small mobile commercial hatchery, which was designed and constructed by Departmental staff, is being utilized as a pilot plant with a view to improving and simplifying current techniques; to assess benefit-cost relationships; to test its suitability for various areas; and to demonstrate the technique to the industry in an effort to arouse their interest in large-scale commercial applications.

2. The Service has had a long-continuing heavy involvement with hydroelectric developments on the Saint John River, New Brunswick,because of the threat they pose to valuable stocks of Atlantic salmon.

Fish-passage facilities, which were designed by the Service, were incorporated into the Tobique Narrows development (1952) and the Beechwood plant (1957), and these have proved effective. However, with the announcement of a third hydro development at Mactaquac several years ago, the Service became very alarmed not only because of the problems presented by the proposal itself but also because of the probable cumulative effects that the three developments could have on the salmon migrations. Subsequent detailed investigations disclosed that substantial losses could be incurred by the salmon stocks, and, indeed, that they might face extinction if fish-passage facilities only were provided at the proposed development.

Accordingly, it was decided that a large modern hatchery afforded the best opportunity for maintaining, and possibly improving the salmon stocks of this river system. This facility, which is now in operation, is capable of rearing 500,000 smolts (juvenile salmon). Ancillary works comprise complex trapping-and-trucking facilities which are employed for the capture and transport of adult salmon to the hatchery, and for the transfer of smolts to release sites.

Inasmuch as the hatchery brood-stock requirements represent only a comparatively small proportion of the total number of spawning migrants, the remainder are captured and transported upriver in specially-designed tank trucks in order to maintain important angling fisheries. An incidental, but promising feature of these facilities is afforded by the fact that since all fish come under the scrutiny of the hatchery staff, selective-breeding practices can be employed to ensure that future generations stem from the best available brood stock.

3. The Service has taken cognizance also of the well-known fact that fluctuating stream flows are a major factor associated with the frequently substantial year-to-year variations in the freshwater survival rates of several species of Pacific salmon; and the concept of increasing salmon production by means of flow stabilization was applied for the first time, on a production basis, by the Service at Jones Creek, B.C. in 1954. The phenomenal subsequent increases in egg-to-fry survival rates, together with the encouraging returns of adult spawners, led to the decision to

proceed with a proposal to develop the Big Qualicum River, on Vancouver Island, for the exclusive benefit of salmon production.

This project, which was initiated in 1957, when intensive bio-engineering studies got underway, is still being pursued, in stages, today. Construction of the flow-control works, which also embody the means to regulate water temperatures, was initiated in 1960, and the project came into service in 1963. The second stage of this project, which was initiated in 1967, has resulted in the expansion and improvement of existing spawning grounds, and the construction of two additional spawning channels having a combined length of 1.5 miles.

To date, approximately two-million dollars has been expended on the project, and while it is still too early to assess its effectiveness, preliminary indications have been promising, and it is confidently expected that the increased landings of chum salmon alone will be worth an additional $400,000 annually to the commercial fishermen.

While the Big Qualicum River project was not constructed as a research tool, it nevertheless fulfills this function inasmuch as the continuing monitoring and assessment process being undertaken by the staff provides knowledge which will play a vital role in the selection, design, and construction of future projects of a comparable nature.

4. When long-term studies undertaken by the Fisheries Research Board revealed that Babine Lake, the major spawning and rearing area for the valuable sockeye salmon runs of the Skeena River in British Columbia, was capable of supporting several times more of this species, the Service initiated investigations and surveys, looking to the development of a suitable plan for expansion of this valuable stock.

Subsequently, when it was determined that availability of spawning grounds in the tributary streams of the lake was the dominant factor limiting salmon production in this system, the Service formulated a major development plan which envisaged improvement of existing spawning grounds, regulation of stream flows, and construction of spawning channels in the two major salmon-producing tributaries, Fulton River and Pinkut Creek.

Fulton River is the principal spawning stream tributary to the main lake basin, having accommodated an average annual escapement of some 80,000 spawners over the last 20 years. The development plan, which is now being implemented, calls for a tenfold increase of the normal minimum flow, with consequent reductions of the damaging peak flows, and construction of spawning channels adjacent to the river to accommodate 165,000 additional spawners.

The first spawning channel constructed on the Fulton River was completed in 1965 at an approximate cost of $500,000. It was designed for 22,000 spawners which were expected to produce some 12-million additional fry, but the average output in the last two years has been 20-million because egg-to-fry survival rates have been three times the long-term average recorded in the natural river.

Comparable plans being implemented at Pinkut Creek provide for a sevenfold increase in its normal minimum discharge, together with the construction of additional spawning areas.

Total cost of the project, which involves the construction of dams, tunnels, pipelines, and ancillary works, as well as new spawning grounds, is expected to reach some 8-million dollars by the time of its completion in 1971, and it is confidently expected that the resulting input of some 125-million additional fry to Babine Lake each year will annually provide the Skeena River fishery with one million additional adult sockeye salmon, which have a value in excess of $2,000,000.

5. A spawning channel for Atlantic salmon was constructed in 1963 on the Indian River, Newfoundland, for the purpose of offsetting losses which otherwise would have been expected as a result of spawning-ground losses caused by a new hydroelectric development.

This installation, which incorporates flow-control works and biological assessment facilities, has been designed to accommodate 750 spawning pairs. Being the first channel constructed for Atlantic salmon it has been studied very closely since it came into operation, and the extensive data collected to date suggest that this concept may be usefully applied in other specific situations.

6. Tandem waterfalls on the Meziadin River in Northern British Columbia obstruct the spawning migrations of a sockeye salmon stock, which annually

contributes some 200,000 fish to the valuable Nass River commercial fishery, to the extent that losses of up to 38 percent of the total migration have been recorded. This represents an economic loss of some $300,000.

In 1965-66, therefore, a fishway and auxiliary works were constructed at this site for the dual purpose of providing safe access to the upriver spawning areas, and eliminating costly delays.

Total cost of this project, including the construction of a 10-mile access road, was $850,000. Evaluation studies have shown, however, that losses and delays have been virtually eliminated at this site.

7. Populations of lake trout and some other important fish species have been seriously depleted in Canadian and United States waters of the Great Lakes as a result of an invasion of parasitic sea lamprey, but effective control of this parasite now appears possible through the application of selective poisons in the streams in which they spawn and rear.

The Department of Fisheries, as Canadian agent for the Great Lakes Fishery Commission, has assigned the lamprey-control task to the Resource Development Service, and a staff of scientists and technicians conduct this program from an office-laboratory headquarters located at Sault Ste. Marie.

The control program consists of stream surveys, to locate those which harbour young lampreys; frequent water analysis and bio-assays to establish the critical chemical levels which are necessary to kill lamprey larvae but not desirable fish species (this varies with each stream and with the season); and the application

of the selective chemical TFM (3 - trifluormothyl - H-nitrophenol), and, wherever possible, a synergist Bayer 73. Furthermore, evaluation studies, which employ electrical barriers, are undertaken on selected streams to collect and enumerate adult sea lampreys as they ascend the weirs to spawn.

After encountering a great many difficulties, the program now appears to be having the desired effect, as assessment studies, in 1967, have indicated that lamprey control in Lake Superior reached a level in excess of 90 percent. In 1968, however, this figure, for some as-yet-unexplained reason, declined to 80 percent.

All known lamprey-producing streams tributary to Lake Superior have now received initial treatment, and if it is possible to continue the program at the planned rate all Lake Huron streams will have received treatment by 1970, when attention will then be directed toward Lake Ontario.

Water Pollution Control

1. Four large pulp mills, which were constructed in the British Columbia interior during the course of the last five years, constituted a very grave threat to the multi-million-dollar Fraser River salmon stocks inasmuch as the oxygen-consuming and toxic wastes from these plants would be discharged into the Fraser River system.

With announcement of the proposals for these mills, the Service, in conjunction with the International Pacific Salmon Fisheries Commission, established liaisons with the companies, and concurrently initiated an intensive literature search to obtain as much information as possible with respect to the composition of pulp

mill effluents, their toxicities, and other data related to their possible deleterious effects on fish and their environment.

These substantial efforts resulted in the preparation of a detailed report which recommended that the new plants be equipped with biological-treatment facilities to eliminate acute toxicity in their effluents; and that the companies should adopt certain in-plant practices which would reduce the quantities of effluent that would have to be so treated.

The report was employed as the main basis of negotiations with the several companies, and these culminated in the installation of suitable effluent-treatment facilities in all instances, establishing an important precedent for the future.

2. Commencing in 1952, large-scale programs were initiated to control infestation of New Brunswick fir and spruce forests by spruce budworms. These programs, which involve spraying of chemicals from aircraft have been continued each year, except in 1959, over areas ranging in size up to five-million acres.

The concentration of the chemical employed in the initial program proved to be highly toxic for fish and fish-food organisms in the waters of the spray area. Consequently, negotiations were conducted with appropriate officials and these resulted in modifications which substantially reduced the impact of the spray programs on fish and their environment. Additional relief has been obtained in the interim through the development of new chemicals of a less-toxic nature which are effective from the forest-industry viewpoint.

Each year, since 1960, the Service has monitored the aerial-spray programs, and it has undertaken extensive studies of the comparative effects of various chemicals, applied at different concentrations, on fish and their food organisms. These studies have shown that fisheries losses stemming from the application of DDT are severe, and directly proportional to the concentration rate, whereas the organo-phosphates phosphamidon and sumithion, or mixtures of both, are not toxic to salmon in the concentrations used.

The results of these studies played a major role in the development of current practices which minimize fisheries losses, while permitting the forest industry to pursue its programs.

Resource Investigation & Management

1. As a result of a continuing concern with respect to the declining abundance of pink and sockeye salmon in the Skeena River system of British Columbia, the Skeena River Salmon Management Committee, comprising representatives from the Department and the Fisheries Research Board, was formed in 1953 to rehabilitate the sockeye salmon stocks; to develop methods for achieving maximum sustained yields; to originate plans for expanding the stocks; to obtain data, on a continuing basis, with respect to the condition of the stocks; and to provide advice in connection with the seasonal regulation of the commercial fisheries.

Precise regulation of the fishery is desirable in order that optimum numbers of each sub-stock escape to the spawning grounds, while ensuring that maximum numbers are available to the commercial fisheries.

The key to this regulative procedure is the test-fishing operation, undertaken by the Service during the entire course of each fishing season. This operation utilizes a standardized unit of fishing gear which is installed upriver from the commercial fishery, and its effectiveness in catching fish can be translated into the daily numbers escaping to the spawning grounds. On the strength of this data, intelligent decisions can be made with respect to advisable adjustments of the fishing periods for the commercial fleet.

The Service also undertakes studies and investigations of such diverse nature as statistical analysis; spawning escapement enumeration and estimates; age composition and racial characteristics of stocks; timing of migrations; and other related matters as required.

2. The chum salmon stocks migrating through the Johnstone Strait-Fraser River area of British Columbia have contributed up to four million fish annually to the commercial fishermen, but commencing in the mid-1950's they underwent a very serious decline which has reduced the catch to as low as 200,000 in recent years.

In 1960, the Service initiated an intensive program of investigations looking to determining the underlying reasons for this collapse. This study, which is still in progress, involves population estimates of the various sub-stocks; enumerations and estimates of spawning escapements; determination of the timing and rates of migration; test-fishing operations; estimates of fry production by various means; operation of chartered commercial fishing vessels to obtain basic data; and other related operations, as required.

These studies have produced much valuable data which has largely been responsible for the application of stringent regulatory measures in recent years. These have been successful to the extent that the decline of the stocks now appears to have been curbed, and, in fact, there has been some indication that they are increasing.

Inasmuch as the migration of pink salmon coincides with that of the chum salmon within the designated area, management of the two species cannot logically be separated. Accordingly, the Service is also obtaining much valuable basic data with respect to pink salmon. Application of this knowledge has resulted in the strengthening of the sub-stocks in at least one former major-producing system, where, within two life cycles, the spawning escapements have increased from 3,500 fish to 50,000.

3. The freshwater life-history of chinook salmon is, perhaps, the least known of all salmon species, largely because it reproduces in relatively large rivers where observations and operation of equipment are extremely difficult and expensive. However, the facilities of the Big Qualicum River project have afforded a unique opportunity to undertake intensive studies of the population dynamics of this species, and of the effects of environmental factors on their freshwater production.

The information so obtained has been employed for the purpose of defining optimum levels of escapement, and for interpretation of population fluctuations, with application in the field of fishery regulation. It has also been valuable in the selection of techniques, looking to the protection and expansion of the chinook salmon resource.

Comparable studies have been undertaken with respect to coho salmon at Big Qualicum River and other sites in an effort to establish relationships between stream parameters and coho production.

4. The contribution of Canadian Atlantic salmon to foreign commercial fisheries operating off the west coast of Greenland has been becoming such a matter of concern that the Service is embarking on a scientific program which is a part of an international investigation designed to ascertain whether or not such losses are substantial.

In this connection, the Service, after several years of surveys undertaken to locate a suitable site, is now constructing facilities at the Sand Hill River in Labrador. When completed, these facilities will enable the Service to undertake a long-term tag-and-recovery program, which, among other things, calls for the affixation of marked tags to Atlantic salmon smolts (seaward migrants). From the information so obtained, coupled with that collected in the Sand Hill River itself, reasonable inferences may be drawn, in time, with respect to the impact of foreign exploitation of these stocks.

5. The tremendous growth in the popularity of the recreational salmon fishery in the tidal waters of British Columbia has been most prominent in the Strait of Georgia, where more than 80 percent of the tidal sport-fishing effort is expended. In this connection, recent annual figures show that 130,000 individuals and 225,000 boat-days were employed to catch 200,000 salmon.

The increasing pressures being applied to the stocks of coho and chinook salmon in the Strait of Georgia caused the Service to initiate a continuing biological investigation to obtain basic data for use in the effective management, of both the commercial and sport fisheries. To date, much valuable information has been collected, and, indeed several regulatory measures have already been effected as a result.

Insofar as the future is concerned, it is foreseen that technological changes in all industries will aggravate the problems associated with the development of solutions to the fisheries problems posed by other water users; that further expansion of the affluence of society, and, in turn, its leisure time, will result in a much heavier public clamor for expansion of the existing sport fisheries to meet the recreational needs; and that increased efficiencies within the fishing industry itself, coupled with a probable increased consumer demand for fish, will give rise to a fishing-industry agitation for expansion of the resource, particularly with respect to such delicacies as salmon, lobsters, and oysters.

It is foreseen also that new or improved scientific techniques will be applied by the Service in future, as technology improves. For instance, artificial propagation of salmon is currently a very promising concept, as is that of increasing oyster production by means of a new hatchery technique which is currently under development in the Maritimes.

Similarly, expansion of the resource by extending the distribution of some valuable stocks through implementation of the transplant technique is attractive in view of the early reports stemming from projects which have been undertaken by the Fisheries Research Board to transplant lobsters to the Pacific coast, and pink salmon to the Atlantic coast. Other agencies have had considerable initial success in their efforts to introduce coho salmon from the Pacific coast into the waters of the Great Lakes.

Finally, it is foreseen that continuous improvement in the basic biological knowledge concerning the resource itself will generate new management techniques which will contribute substantially to the enhancement of the fisheries resource and, hence, the nation and its economy.

INSPECTION SERVICE

Systematic fish inspection procedures were not implemented in Canada until after the passage of the Fish Inspection Act, 1914. In the subsequent two decades inspection was confined to pickled fish and salted fish which was destined for export markets, and this activity therefore was of no direct consequential benefit to the Canadian consumer. In 1934, however, systematic inspection of canned Pacific salmon was initiated, largely at the urging of the British Government.

During World War II, the British Ministry of Foods, and subsequently UNRRA, insisted that their purchases of frozen and canned fish had to be inspected and certified by qualified Government inspectors. By the end of the war, many persons in government and industry were convinced that there was a very real need for implementation of quality standards and systematic inspection procedures if the fishing industry was to continue in peacetime as a viable industry in competition with agricultural foods.

In recognition of the growing needs, the Inspection Service, as it is called today, was created in 1949 as part of a major reorganization of the Department of Fisheries. By 1953, the Service was convinced that the rapidly expanding output of fresh and frozen fish products was not of consistently good quality. Furthermore, and of even more fundamental significance, it recognized that fish processing establishments frequently provided an environment which was not conducive to producing a sanitary product. It was concluded therefore that there was an urgent need for compulsory systematic controls over the production, processing, and storage of fish products as a means of protecting the consumer and increasing the domestic and export sales of the products. Accordingly, the Department, in 1953, sought and received Cabinet approval to expand the staff and facilities of the Inspection Service with a view to developing a national fish inspection and quality control program.

Implementation of the actual program was neither easy nor rapid. In this connection, a national survey of all fish handling, processing, and storage establishments (nearly 1,000) was required in order to define their existing environments and their shortcomings, as well as to develop suitable corrective measures. Next, it was necessary to evaluate the findings of the survey and translate these into terms of staff, funds, and equipment which would be required to implement the new inspection policy. Finally, it was necessary to develop regulations which would make the new policy enforceable.

The Department is of the view that a fish inspection program will be afforded the best chance of success if it is developed as a cooperative effort of government and industry working in an atmosphere of mutual confidence and respect. In this connection, it has been concluded that a fish inspection program based solely on the enforcement of laws and regulations will not be successful inasmuch as coercion, by itself, will not encourage the development of a reputable industry which takes pride in its products. On the other hand, it is unfortunate that within the fish processing and marketing industry there are, as in most other endeavours, unprincipled elements which look for financial profit by trafficking in low-quality products. Regulations are therefore required to provide for uniform minimum standards of quality in the interest of protecting the consumer; to stabilize the industry; and to protect the industry, as a whole, from an unfavourable public image, by imposing restrictions on the production and sale of low-quality fish products.

The Fish Inspection Act, the Meat and Canned Foods Act, and Regulations made thereunder define the Department's inspection responsibilities; and, with the appropriate authority emanating principally from this legislation, the objectives of the Inspection Service are:

To develop, and apply at all levels of production, distribution, and storage, a program of fish inspection which will

- protect the health of the consumer,
- ensure that fair trade practices are observed which prevent fraud and deception, and
- create confidence in consumers by maintaining a consistent level of high quality in fish and fish products.

To develop and undertake programs of applied and developmental investigations for solving problems in the handling at sea and on shore, processing, preservation, storage and distribution of fish and shellfish so that consistently good quality can be achieved.

To demonstrate to fishermen and industry new and improved processes, techniques and equipment for better quality control of fish and shellfish which will reduce wastage, improve quality and increase earnings.

To develop new fish and shellfish products from

- commercial species of fish now being landed,
- species of fish now discarded at sea,
- species of fish known to be available in commercial quantities but which are not now being taken.

In order to fulfill these objectives the Department deploys its inspection staff across the entire nation, with functional direction being provided by a small staff located at Departmental headquarters.

Inspection personnel are attached to each of the five administrative regions of the Department, and direction of the programs in each is the responsibility of the Regional Director. The latter discharges this responsibility through a Regional Chief of Inspection, who, in turn, directs the programs in the administrative districts, sub-districts, and laboratories.

The current establishment of the Inspection Service provides for 104 scientific positions, 20 of which are vacant, and six others are occupied at the present time by non-professionals. The numbers of employees possessing Bachelor degrees (Master's shown in brackets), by discipline, are: engineering - 6 (1); bacteriology - 11 (6); chemistry - 10 (3); and food technology - 41 (nil). Eight of the professional employees devote most of their time to administrative duties. The average age of the professional staff of the Service is 35 years.

Twelve individuals can operate effectively in Canada's two national languages. Of the remainder, 49 operate in English only, whereas 13 others are able to read French, three can read and write French, and one speaks and reads French.

Particulars with respect to the professional staff's countries of birth, employment histories, etc., are set forth in the accompanying tables.

Country	Birth	Secondary Education	University Education Bachelor	University Education Master
Canada	66	67	73	9
Poland	1	-	-	-
U.S.S.R.	1	-	-	-
South Africa	1	1	1	-
China	2	2	-	-
France	1	1	1	-
Egypt	1	1	1	-
West Indies	1	1	1	-
Italy	-	1	-	-
Hong Kong	1	1	-	-
Jamaica	1	1	-	-
Hungary	1	1	-	-
Greece	1	1	-	-
Taiwan	-	-	1	-
U.S.A.	-	-	-	1

No. of Years	Bachelor Since Grad.	Bachelor With Dept.	Master Since Grad.	Master With Dept.
0	6	8	1	1
1	11	14	2	3
2	11	13	1	2
3	7	7	-	1
4	1	-	1	1
5	2	1	-	-
6	-	1	-	-
9	-	2	-	-
10	3	6	-	1
11	3	2	1	-
12	-	1	-	1
13	-	1	-	-
14	-	1	1	-
16	2	1	-	-
17	-	1	-	-
18	3	-	1	-
19	2	-	-	1
20	8	5	-	-
22	2	1	1	-
23	1	1	1	-
24	2	-	-	-
25	1	1	-	-
26	1	-	-	-
33	-	1	-	-
35	1	-	-	-
36	1	-	-	-

Total Number on Staff

Year	Bachelor	Master
1962	32	3
1963	32	3
1964	31	3
1965	33	3
1966	42	4
1967	53	6
1968	71	7

Number of Staff

Year	Bachelor Hired	Bachelor Released	Master Hired	Master Released
1962	-	-	-	-
1963	2	3	-	-
1964	4	2	-	-
1965	14	5	1	-
1966	18	7	2	-
1967	27	9	1	-

The employment histories of the current professional staff, expressed as a percentage of the total, has been: industry - 19; university faculty - 6; provincial governments - 13; and other federal departments - 12.

One individual who possesses a Bachelor's degree is currently on educational leave, as are 19 non-professional inspectors who are in pursuit of B.Sc. degrees. Approximately 10 student assistants are employed by the Service during the summer recesses to undertake laboratory assignments.

Until the late 1940's, the inspection function was undertaken by a corps of inspection officers consisting of non-professionals who were provided with on-the-job training. Their chief duties were to inspect end-products organoleptically for conformity to specific regulatory standards,and to ensure that containers were marked in accordance with regulatory requirements.

Bacteriologists and chemists were added when it became necessary to implement a more precise system of inspection because of the development of more sophisticated products, evolution of a more discriminating consuming public, and application of more stringent requirements by importing countries. This development led to the establishment of Fish Inspection laboratories across Canada. The importance of the application of scientific principles to the processing environment led to the ever-increasing utilization of professional laboratory staff in field activities.

In recent years, the Inspection Service has redirected its program, giving far more weight to the concept that a favourable environment during handling, processing, storage and distribution, coupled with a completely sanitary operation throughout, is far more effective in obtaining a high-quality product than that which would result from a greater effort in policing the end-product.

The redirection of environmental and sanitation considerations has necessitated an increase of professional competence in field activities. In order to meet this requirement, vacancies which have occurred in the field during the last few years have been filled by university graduates in science, majoring in a subject related to food technology. Before assignment to a field location, these graduates, referred to as Fish Quality Specialists, undergo extensive in-service training for a period of about one year to provide a basic knowledge of the fishery resource, Departmental standards and procedures, and laboratory techniques. The original class of inspection officers was afforded opportunity to become fully qualified as Fish Quality Specialists by being encouraged to attend university in order to obtain the necessary university degree. Those who were qualified for university entrance and who wished to attend were provided, during the period of attendance, with an allowance equivalent to full pay.

The original group of fish inspection officers will continue to play a vital role in plant and product inspection and may be regarded as essential technical support for professional staff.

Very recently an engineering discipline was added to the professional competence of the Inspection Service. This, together with the deployment of Fish Quality Specialists and

professional laboratory staff, enables the Inspection Service to provide a broad range of technical and scientific advice to the industry. These recent improvements in professional capabilities enable the Service to assist the industry with its more urgent specific problems. When solutions to problems are not immediately available, investigations of an applied research nature may be undertaken. This approach is not an infringement on the duties and responsibilities of the Fisheries Research Board as such problems, by their very nature, frequently have only a single or specific application. Because of the wide dispersal of the industry and the comparative centralization of the Board's establishments, Departmental officers provide the only essentially close contact with the individual units of industry and it would be impractical and uneconomic for the Board to undertake applied research projects within the competence of the Department's field officers. Programs requiring Board expertise are, of course, referred to that organization. Because of its closeness to industry, the Department's field staff is in an excellent position to transmit and translate to industry any significant developments stemming from the Board's programs.

The very nature of the responsibilities of the Inspection Service requires that a close liaison be maintained not only with the industry but also with other governmental agencies at the provincial, federal, and international levels. In this connection, the following contacts are representative, but by no means exhaustive.

- All matters relating to the public health safety of fish and shellfish products are discussed with officials of the Food and Drug Directorate of the Department of National Health and Welfare, not only at headquarters but also within the regions. Scientific liaison may be

regarded as a continuous operation at the headquarters level. Contacts are particularly close with regard to the effects of, and tolerances for food additives and preservatives. Harmful contaminants constitute an area of mutual concern, and, as an example of the close co-operation which exists, there is currently underway a joint program on the Pacific and Atlantic coasts looking to assessing the presence of pesticides in molluscan shellfish.

- Another division of the Department of National Health and Welfare with which this Service has a close liaison is the Laboratory of Hygiene, which has the professional competence to type pathogenic micro-organisms such as salmonella. The urgency of this service dictates that the Department's regional offices establish direct contact with the Laboratory.

- The Service is permanently represented on an interdepartmental committee, chaired by the Epidemiology Division of the Department of National Health and Welfare, which was formed to cope with health authorities' increasing concern with respect to the salmonella situation.

- Continuous liaison is maintained with the Public Health Engineering Division of the Department of National Health and Welfare because that agency maintains close contact with United States authorities with respect to the importation and export of Molluscan shellfish; it is responsible for closures and openings of shellfish areas, as determined by shellfish toxicity or water pollution; and it is regarded as the ultimate Canadian authority on matters involving water quality.

- Liaison is maintained with the Department of Agriculture's Health of Animals Branch in connection with a number of matters relating to scientific activities, an example of which is the development and application of standards for whale processing plants and for whale meals.
- Close contact is maintained with the Plant Products Division of the Department of Agriculture, particularly with respect to matters relating to fish meals; and a joint program of testing of fish meals for the presence or absence of salmonella organisms and for proximate analysis has been underway for more than a year. This close contact maximizes efficiency of the two groups and eliminates duplication of effort.
- Increasing contacts are being made with the Food Research Institute with respect to processing methods.
- The Service cooperates with the National Research Council and participates with that agency in joint programs, an example of which is a recent study related to the refrigerated transport of frozen fish products from coastal ports to central-Canada metropolitan centres. Continuation of this valuable study is contemplated.
- Involvement of the Service in the application of policies of the Atlantic Development Board has been extensive in connection with consultations regarding water supplies for fish processing plants in the Atlantic provinces.
- Effective coordination exists with the Department of Consumer and Corporate Affairs, and, in fact, this Department is represented on the Interdepartmental Committee on Consumer Affairs, while the Inspection Service is represented on the Subcommittee on Deceptive Trade Practices, and that on Food Grades.

- Contact is maintained with the Department of Indian Affairs and Northern Development in connection with the latter's endeavours to develop Indian and Eskimo fisheries in the Northwest Territories, and the Service's involvement with the quality of the products.
- Liaison with the Department of Trade and Commerce is confined almost exclusively to matters relating to the acceptability of Canadian fishery products in the world markets.
- Contacts with the Department of Defence Production are restricted mostly to the operations of the Canadian Government Specifications Board (CGSB), and certification procedures employed by Departmental officers with respect to the quality of fish products. The Director of the Inspection Service is Chairman of the Board's Committee on Foods, as well as that on Fish and Fish Products.
- Intermittent liaison exists with the Department of External Affairs in connection with the Service's planning and coordination of itineraries and courses of instruction for trainees from underdeveloped areas of the world.
- The Inspection Service is heavily involved with the activities of the Interdepartmental Shellfish Committee which comprises representatives from other Services within the Department of Fisheries, the Fisheries Research Board, various divisions of the Department of National Health and Welfare, and several provincial governments, as well as observers from the U.S. Department of Health, Education and Welfare. The Chairman and Secretary of this Committee are officers of the Inspection Service.

In addition to the foregoing federal liaisons, the Service takes an active role on the international scene, particularly with regard to scientific activities within the Joint FAO/WHO Codex Alimentarius Commission. In this connection, the Service

Director is heavily involved with the Committees on Fish and Fishery Products, General Principles, and Food Labelling, while the Assistant Director is a member of the Committee on Food Hygiene.

Continuous informal liaisons are maintained also with United States agencies such as the Bureau of Commercial Fisheries and the Food and Drug Administration, and with the British Ministry of Technology to exchange information and discuss outstanding problems of mutual concern.

The Service is also in contact with other international bodies as the situation demands, but these usually are of a non-continuing nature relating to prevailing situations, letters of inquiry, and other short-term matters.

The continuing emphasis which the Service is placing on the recruitment of professional staff, and the impetus which this has given to applied and developmental research, has required that the Service establish close liaisons not only with other governmental agencies, but also with all segments of the industry itself, the transportation industry, and equipment manufacturers.

Significant projects to which the Service has contributed, in whole or in part, are represented by the following typical examples:

- development of an optical instrumentation system for evaluation of the colour of canned salmon and canned tuna by comparisons with standardized colours to facilitate the grading of products with a view to assuring uniformity of colour in the packs for national and international markets.

- design and installation of a new improved refrigeration system for use in welded aluminum-alloy holds of fishing vessels, which takes advantage of the heat-conductive properties of both the aluminum and salt water, thereby maintaining fish quality over extended periods with greater refrigerative efficiency, while reducing the difficulties associated with the maintenance of sanitation requirements within the hold.
- development of new or improved equipment and techniques for handling and processing of fish aboard vessels, and in plants, for the purposes of increasing efficiencies, and reducing the bacterial loading of the end product.
- in cooperation with the National Research Council, the trucking industry, and manufacturers of refrigeration equipment, the Service has developed, tested, and evaluated a new and improved system for highway transport of frozen foods; the main principle being the envelopment of the product load with refrigerated air in such a manner that the effects of heat ingress through the surrounding insulation is nullified.
- development of a new and improved method of preserving the quality of fresh fish fillets, (and, incidentally, extending their subsequent shelf-life period in the stores), during the course of their transportation to the major markets involves a super-chilling procedure, whereby the fillets are cooled in the processing plant, to a temperature slightly above that at which fish muscle freezes, and this temperature is maintained in the mechanically refrigerated vehicles in which they are transported to the markets.

- continuing development of methods for the handling and processing of Atlantic "Queen Crab" to assure high-quality frozen and canned products is assisting in the rapid growth of this new industry, utilizing a previously unexploited species which presents especially difficult problems in connection with live storage and processing.

- development of criteria for the handling, processing, and inspection of Reinhardtius hippoglossoides (Greenland halibut) for marketing in the frozen state has materially assisted in the establishment, within recent years, of a new industry which reached an export peak in 1967 of some twelve-million pounds.

Inasmuch as the scientific activities of the Service are primarily oriented toward applied, as opposed to basic research, publications prepared by staff members for scientific journals are not extensive. Substantial numbers of reports are prepared, however, for the internal use of the Department and for the benefit of the industry. In this connection, the following selected list of publications and reports are representative, and the individual titles suggest the variegated nature of the Service's scientific activities.

- Handbook of Standard Methods of Bacteriological Analyses for Fish Inspection Laboratories. 1966

- A Critical Survey of Differential Media for the Demonstration of Coagulese-Positive Staphylococci in Foods. Can. Fish. Reports, Oct. 1963.

- Use of Standardized Colour Surfaces in the Grading of Canned Salmon for Colour. Jour. Fish.Res.Bd., 24, 1613, 1967.

- Requirements regarding Vacuum in Canned Fish. 1962
- Significance of Coliforms and Enterococci in Fish Products. Applied Microbiology, Feb. 1968.
- Factors Affecting the Efficiency of Antibiotic Dips for Fresh Fish Fillets. Can. Fish. Reports, Oct. 1963.
- Coliform Contamination in Lobster Meat Traced to Cooler Construction. Can. Fish. Reports, Oct. 1963.
- Quality Changes in Vacuum-Packed and Non-Vacuum-Packed Frozen Lobster Meat during Storage at Different Temperatures. Can. Fish. Reports, Oct. 1963.
- The Relationship between Faecal Coliforms in Oysters and Overlying Waters and the Effect of Climatic Conditions on Pollution Levels at Boundary Bay.
- The Incidence of Non-sterility in Canned Shrimp showing no Evidence of Organoleptic Degradation. 1965.
- Experimental Extraction of Paralytic Shellfish Toxin using Stainless Steel Beakers. 1966.
- The Extent of Pesticide Residue Accumulation in B.C. Oysters from Several Areas. 1967.
- Identification of Salmon Species by Refractive Index and by Scale Study. 1967

Papers which currently are being prepared for publication are listed hereunder:

- Superchilling - A New Technique for Processing and Marketing Fresh Fish Fillets.
- Effect of Refrigerated-Sea-Water Chilling on the Landed Quality of Scallops.
- Technology of Queen-Crab Processing.

Staff participation in various regional, national, and international technological conferences has produced a number of scientific papers, of which the following are typical:

- Polyphosphate as a Dip for Fishery Products
- Future Concepts in Fisheries Technological Problem-Solving.
- Role of Tissue and Bacterial Enzymes in Post-Mortem Biochemical Changes in Fish.
- The Dual Problem of Water Supplies and Sewage Disposal for Fish Plants in the Maritimes Area.
- Problems of Coliform Evaluation in Water and Fisheries Products.
- Bacterial Aspects of Quality Control.
- Review of the Shellfish Toxicity Control Program in British Columbia.
- The Development of a Method of Canning Toxic Clams that will reduce their Toxicity to a Safe Level.

It is foreseen that the evolution of the more scientific approach to fisheries inspection matters will continue for a further period of about five years, after which the situation probably will become stabilized with a proper balance between professionals and the technical support provided by inspection officers. During this period it is anticipated that there will be a broadening of applied research and development activities as professional competence grows and experience is gained.

Activities in the applied research and development field quite often stem from the urgent needs of the fishing industry as it strives to maintain or increase its share of the consumer food dollar. However, the requirements of export markets may frequently dictate the direction of such Departmental efforts. The public health considerations of fish and fishery products influences priorities between various research activities as does, at times, the compelling needs of other Departmental or federal services.

ECONOMICS SERVICE

Economic rationalization of the Canadian fishing industry cannot be achieved without close coordination of such important factors as the availability of the primary resource; the marketability of its products; the impact of explorations for new stocks; the effects of fisheries management techniques; the ramifications of increased efficiencies of the fishing and processing equipment, and of the skilled manpower; and consideration of geographical conditions.

The Department of Fisheries assumes the major role in recognition of these factors, and it therefore coordinates the activities of many agencies which are concerned with one or more of them. In this connection, the Economics Service bears responsibility for the Department's economic research and intelligence functions.

Management of Canada's fisheries resources and the development of the industry itself (and, hence, regional economies) define the policy-making areas within the Department. Accordingly, the economic research function within the Service has been divided into two sections: one deals with resource Management, while the other concerns itself with Regional Development.

While most of the necessary field work is undertaken by Economics units attached to each of the Department's administrative regions, with the exception of the Quebec Region, most of the professional staff is located at the Service headquarters. Underlying this principle of concentrating the majority of the staff at one central location are the concepts that programs and projects are given more positive direction, and that the quality of the work output improves if project leaders are able to have frequent consultations with their colleagues. Furthermore, this arrangement, whereby a central pool of expertise may be drawn upon to meet urgent national problems, provides a degree of flexibility which would not be in evidence if the relatively small research staff of the Service were deployed among the individual regions.

Currently, the personnel establishment of the Service's research unit provides for 17 professionals, but two of these positions are now vacant. Of the remainder, seven of the incumbents possess Master's degrees in Economics; seven others have Bachelor's degrees in the same field of specialization; and there is one employee who has a Bachelor's degree in Mathematics.

Thirteen of these individuals were born in, and acquired their secondary education in Canada; one was born in the West Indies and received his secondary education there; while the other was born in Malta, but took his secondary education in the United Kingdom.

The entire group, which averages 37 years of age, acquired all of their university education in Canada, and, at present, two are proficient in Canada's two national languages.

The following table outlines their areas of employment since graduation.

Bachelor No. of Years		Master No. of Years	
Since Graduation	With Department	Since Grad.	With Department
1-less than 1 year	1-less than 1 year	1-5 years	1-2 years
1- 1 year	1- 1 year	1-8	1-7
2- 2 years	3- 2 years	1-15	1-13
1- 3 "	1- 3 "	1-21	1-17
2- 4 "	1- 4 "	2-30	2-18
1-22 "	1-10 "	1-32	1-27

The establishment has varied only slightly during the 1962-68 period, and no significant changes are foreseen during the course of the next five years.

The percentage turnover within the professional staff at the Bachelor level was nil in 1962, and in the years 1963 to 1967 inclusive, it was respectively 18, 12, 6, 12 and 28 percent. In the case of those having Master's degrees, the percentage turnover during this same period was nil, with the exception of 1965, when it was six percent.

The employment history of the current staff with Bachelor degrees (Master's shown in brackets), expressed as a percentage of the total staff, has been: industry-12 (18); university faculty-nil (12); provincial government-12 (6); other Federal department - nil (30); and foreign government - nil (12). One employee, who possesses a Master's degree, is currently taking educational leave from the Department.

Several university students have been engaged during the summer recess for economic research work with the Service.

The Service's duties and goals are defined by the departmental administration's requirements for economic guidance as it relates to the policy-making role. Accordingly, the effectiveness of the Service's functions can be measured only in terms of the extent to which research findings are employed in the formulation or application of policy.

The research input from the Service embraces studies of the efficiency of the industry at all levels of production; the world's demands for fish and fish products; the growing importance of the recreational fishery, as it relates to the general public and to the commercial fishing industry; and other related matters.

During the course of these studies, liaison with other federal departments and agencies such as the Atlantic Development Board, the Area Development Agency, ARDA, the Department of Trade and Industry, and the Dominion Bureau of Statistics are maintained.

Close associations are maintained also with the Fisheries Council of Canada, its member associations, and the fishermen's organizations, inasmuch as these groups, together with the departmental administration, are the principal users of the results emanating from economic research projects. Furthermore, these groups are also the prime source of data for such research. In both instances, however, arrangements are mostly of an informal nature.

Liaison is maintained, too, with provincial fisheries administrations, which are also sources of data and users of research output, by means of formal Federal-Provincial Fishery Committees, and their subsidiary working groups.

On the international scene, the Service maintains informal arrangements with agencies such as the United States Bureau of Commercial Fisheries, the Food and Agricultural Organization of the United Nations, and the Organization for Economic Cooperation and Development, for the purpose of developing and coordinating economic research, particularly as it relates to international resource management.

Good relationships are maintained also with several universities receiving grants or contracts from the Service for research projects which supplement or complement work undertaken by its own staff. Moreover, it has been found that such arrangements not only stimulate academic research in the field of fisheries economics, but also it introduces graduate students to the problems of this science, and the more promising ones are encouraged to pursue a career within the Service.

While universities generally are oriented more toward basic research, as opposed to applied research, management consultants, and others in the business world, are engaged, from time to time, to undertake investigations of immediate problems with which the Service's staff may not be able to cope because of prior commitments or other reasons.

Currently, the services of universities and management consultants are being utilized to investigate such aspects of the fisheries economy as the underlying motivation of those individuals who enter the salmon sport fishery on the West Coast; the development of the fisheries of the Northwest Territories, as related to the employment of the native peoples; the impact of recent technological advances and other factors on the administration of the Atlantic oyster fishery; the rationalization requirements of the Atlantic ground fishery in relation to the marketability of its products; and the productivity implications of the program by which certain Newfoundland fishermen and their families are being re-located in more viable communities.

Other investigations undertaken by the Service, sometimes in conjunction with consultants, during the last five years are: a cost-and-earnings study of the Atlantic fishing fleets, which has been updated each year since 1952;

rationalization studies of such diverse fisheries as those of the Northwest Territories, and that of Pacific salmon, Atlantic lobster, and groundfish off Newfoundland; and benefit-cost studies of the Great Lakes lamprey-control program and the Newfoundland household-resettlement program.

The following selective list of reports published by the Service during the last five years is representative of the scope and variety of projects which have been undertaken:

Proskie, J., Costs and Earnings of Selected Fishing Enterprises, Atlantic Provinces, Vols. 10-14, Ottawa. 1962-67.

Molson, C.R., Resource Inventory in Newfoundland Waters, St. John's, 1963.

Cormier, M.C., Survey of the Credit Needs of Fishermen in Newfoundland, St. John's, 1963.

Various authors, "The Economic Aspects of Sports Fishing" (papers and proceedings of symposium), in Canadian Fisheries Reports, Ottawa, 1965.

Frick, H.C., Economic Aspects of the Great Lakes Fisheries of Ontario, Ottawa, 1965.

Campbell, B.A. and Young, S.L., A Review of Gross Fishing Returns in British Columbia, 1963 and 1964, Vancouver, 1965.

Campbell, B.A. and Roberts, R.F.A., A Review of Gross Fishing Returns in British Columbia, 1966, Vancouver, 1967.

Campbell, B.A. and Roberts, R.F.A., A Review of Recent Trends in the British Columbia Salmon Fishery, Vancouver, 1967.

Sametz, Z.W., and MacLean, D.A., Trends in the Development of the Canadian Fisheries: Background Document for Fisheries Development Planning, Ottawa, 1967.

Rutherford, J.B., Wilder, D.G. and Frick, H.C., An Economic Appraisal of the Canadian Lobster Fishery, Ottawa, 1967.

Sinclair, S., Trachtenberg, S. and Beckford, M.L., Physical and Economic Organization of the Fisheries of the District of Mackenzie, Northwest Territories, Ottawa, 1967.

Other reports and papers prepared during this period, which are now awaiting publication, include the following:

Spargo, R.A., Evaluation of Sports Fisheries: an Experiment in Methods.

Mensinkai, S.S., Plant Location and Plant Size in the Fish Processing Industry of Newfoundland.

Drugge, S., An Economic Analysis of the Great Slave Lake Fishery.

Frick, H.C. and Tuomi, A.L.W. (joint author and contributor, respectively, with Brinser, A. et al.), An Economic Evaluation of Sea Lamprey Control and Lake Trout Restoration in Lake Superior.

Morse, N.H., An Economic Study of the Oyster Fishery of the Maritime Provinces of Canada.

Mitchell, C.L., An Economic Appraisal of the Operations of the Fishermens Indemnity Plan, 1953-65.

Cormier, M.C. Survey of the Fisheries of Cape Breton Island (tentative title).

Millerd, F., The Potential Net Economic Value of the British Columbia Commercial Salmon Fishery.

MacKenzie, W.C., A Study of Production Costs in the Primary Sector of the B.C. Salmon Fishery.

In the view of the Service Directorate, the most significant project undertaken within the last five years is that associated with the control of entry into the Pacific salmon commercial fishery, where, at the present time, too much equipment and too many men are competing for a limited sustainable catch, causing returns in capital and labour to be inordinately low. In this connection, economic models have indicated that the same catch could be taken with half the effort, and, in view of these indications, steps have been taken to restrict the numbers of fishermen and vessels through implementation of a form of licence limitation which, over a reasonable period of time, will result in the phasing out of marginal or inefficient vessels and manpower without infringing on the valid rights of the individual.

Implementation of this consequential decision stems largely from the work of economists in Canada and abroad, who, commencing in 1955, have proceeded to develop the theoretical background for the concept of licence limitation in a public fishery. In this connection, it is pertinent to note that international symposia, to which the Service contributed, were convened in Rome in 1956, and in Ottawa in 1961, to discuss this important subject.

The first of several empirical investigations of the West Coast salmon fisheries was initiated in 1959, and it was accompanied by a clamor from fishermen's associations seeking restriction of entry into the fishery. These investigations, which, when coupled with theoretical studies, led to the special licencing of fishing craft, effective April 1, 1966, culminated in the announcement of the Minister of Fisheries on September 6, 1968, that regulations to control entry into the West Coast salmon fishery would be implemented in 1969.

The Service Directorate is of the view that this action constitutes an important forward step, giving real meaning to the theoretical and empirical studies which have been underway for at least a decade.

Comparable action, which is supported by appropriate related studies, is being implemented in connection with the lobster fisheries of the Atlantic coast, but such action, which was conceived at a later date, lags behind that of the West Coast salmon fisheries.

Looking into the future, it is foreseen that the Service will have to reorganize in order to improve its capability to provide specialized advice with respect to such important matters as the growing impetus of the sport fisheries, their impact on the resource, their contribution to the national economy, and matters bearing on their effective management.

While it may be presumptuous to gaze into the future, insofar as the impact of technological advances is concerned, it seems quite improbable that there will be any within the next decade which will rival that introduced by the development of the electronic computer. Nevertheless, there is reason to

believe that technological changes, which only affect the Service in an indirect way, are likely to be of considerable significance, particularly with respect to the mechanization of the fishing fleets and processing plants, the implications of which would suggest, possibly, augmentation of costing and related studies.

INDUSTRIAL DEVELOPMENT SERVICE

The Industrial Development Service of the Department of Fisheries was created in 1955 for the purpose of assisting with modernization of the national fishing industry, which was then for the most part, so obsolete or so obsolescent that governmental assistance was a necessity in the interest of the national socio-economic welfare.

In the interim, the Service, through its various programs and projects, has been endeavouring to upgrade the calibre of the industry, or more precisely, certain segments of the industry, by providing financial assistance and technical advice, in cooperation with the industry itself, and, frequently, with certain provincial government administrations.

In the first half-decade after its formation, the Service concerned itself mostly with the delineation and study of the main problem areas; financing of developmental projects undertaken in conjunction with the expert advice provided by the Fisheries Research Board of Canada; and the administration of federal subsidies for fishing vessel construction, and for fishing bait in Newfoundland, the latter being a condition of the terms of Confederation with that Province.

By 1960, however, investigations of the general problems confronting the industry had progressed to the point where the Service believed that it could commence to implement corrective action; and, in that year, with the initial appointment of the first technical personnel, formulation of definite programs, designed to assist the industry, were actively pursued for the first time.

At about the same time, some provincial governments began to show an encouraging interest in fisheries development programs, and, with the introduction of cost-sharing arrangements in 1961, they became very active in this field, undertaking joint programs in conjunction with this Service.

Formation of four regional Federal-Provincial Fisheries Committees (British Columbia, Prairie, Ontario, and Atlantic) has given an impetus to the Service's programs, particularly in the Atlantic region, where the basic problems were greatly compounded by the union of Canada and Newfoundland in 1949, and by the fact that few, if any, modern deep-sea fishing vessels were operating out of east coast ports.

As late as 1960, more than 90 percent of Newfoundland's 15,000 fishermen were relying on small open boats, while the Atlantic deep-sea fishing fleet consisted mostly of second-hand inefficient vessels imported from other nations. Moreover, the Newfoundland industry was composed chiefly of small long-established family businesses which tended to be highly inefficient.

In recognition of these shortcomings, the Federal government, through the then Minister of Fisheries, announced a policy whereby cooperative assistance to the provinces would be available in all matters relating to the updating of the industry, including explorations for new stocks, and development of new fishing gear and techniques.

A further important step was taken in May, 1966, when the Parliament of Canada passed the Fisheries Development Act, which is a fundamental delineation of the Department's responsibilities in this field.

In line with these developments, the basic objectives of the Service are:

- To expand and modernize Canada's commercial fishing industry, in cooperation with the provinces and with the industry itself

- To increase productivity within the industry by designing and demonstrating new and improved fishing vessels, gear, and equipment
- To improve skills in traditional fisheries, and to introduce new more-efficient techniques by providing specialized technical assistance drawn not only from within Canada, but also from other nations
- To achieve greater diversification of the industry by undertaking exploratory fishing operations for the purpose of harvesting under-exploited and currently unexploited stocks.

Vigorous pursuit of these objectives was assured during the current year when Treasury Board granted approval to a proposed reorganization of the Service to provide for an eventual establishment of 75 persons, with emphasis being placed on the recruitment of professional and technical personnel.

Henceforth, the activities of the Service will be undertaken by three discrete divisions, which, of course, will be coordinated by the Directorate: the Fishing Operations Branch will be primarily concerned with the development, testing and demonstration of new fishing gear; the Exploratory Fishing Branch will undertake reconnaisance surveys for new stocks, and promote those which are deemed to be of commercial value; and the Vessel and Engineering Branch will be concerned with modernization of the fishing fleets and related facilities.

Staff specialists in each of these fields are retained at Service headquarters principally for the purpose of conceiving and supervising worthwhile programs and projects, evaluating priorities, and monitoring progress; but the Service does not

yet have the manpower, or, in some instances, the highly specialized expertise which is required to execute such programs and projects. The role of the Service therefore leans heavily, but not exclusively, toward the staff function.

For instance, explorations for new stocks usually are undertaken by experienced fishermen and chartered fishing vessels, operating under the sponsorship and direction of the Service; and the biological studies related to such explorations are undertaken, on request, by the Fisheries Research Board. Moreover, whenever the Service concludes that techniques and processes employed in other parts of the world could be applied effectively in Canada, it arranges for the importation of such expert knowledge from other countries, or engages the experts themselves, for the purpose of educating the Canadian industry in these techniques.

Similarly, while the Service retains naval architects, electronics experts, and other highly qualified specialists on its staff, it does not have the manpower to complete detailed designs. Accordingly, projects such as new designs for fishing vessels are contracted out to naval architects in the private sector; and development of new electrified fishing gear, instrumentation, and the like is turned over to consulting electronic firms.

The problems to which the Service is addressing itself are not necessarily peculiar to Canada alone, and for this reason, the Service sends representatives to international meetings such as that of the International Maritime Consultative Organization, which is concerned, among other things, with vessel stability, and those of the United Nation's Food and Agricultural Organization, which periodically convenes international meetings for the purpose of airing problems of common concern. Meetings and symposia convened by other agencies are attended by appropriate members of the staff whenever the subject matter is particularly topical to the Service. Moreover,

personal visits are arranged with other fishing nations such as Norway, Iceland, Denmark, and Spain whenever the Directorate deems these to be in the interest of the Service's programs; and the Service maintains informational exchange arrangements with the White Fish Authority (Great Britain), the United States Bureau of Commercial Fisheries, and others.

Programs and projects originate from within the Service, or, as a result of requests received from provincial governments and private industry. Those which are deemed to be of sufficient merit usually are undertaken or financed by the Service alone, or with provincial or industry support.

The success, or otherwise, of the Service's programs and activities are not always readily apparent, nor can they be easily delineated, because of the multiplicity of factors involved. Sometimes, however, the contributions of the Service to regional development are particularly evident, as, for instance, the development of the Irish Moss industry in Prince Edward Island, and the Queen Crab fishery in the Maritime Provinces, both of which are established new industries, resulting from a major input by the Service.

The very nature of the Service's activities dictates that it must maintain close liaison with regional development agencies such as FRED, ARDA, the Atlantic Development Board, provincial governments, and others in order to coordinate projects founded on the fisheries resource.

The results of the Service's investigations are published in Departmental reports which are made available to all interested parties, and whenever these are deemed to be of particular value to certain segments of the industry, the Service draws such matters to their individual attention by

means of correspondence or personal contact. Examples of reports of particular significance to date are those related to investigations leading to the establishment of the queen crab industry and the expanded herring industry on the Atlantic Coast.

Moreover, articles concerning the activities and results of the Service's programs are prepared for publication in trade journals such as the Department's *Fisheries of Canada*, and commercial publications, including *Fishing News*, *Canadian Fishermen*, *Fishing World*, *Fishing News International*, and others.

The Service also arranges for formal conferences, looking to promote exchanges of information with respect to topical matters of mutual interest or concern. In this connection, major conferences of international importance which have been sponsored by the Service in cooperation with the Federal-Provincial Atlantic Fisheries Committee in recent years are those convened to discuss the Canadian Atlantic herring fishery (May, 1966), Canadian off-shore fishing vessels (October, 1966), fish protein concentrate (October, 1967), and fishing-vessel construction materials (October, 1968).

An outstanding example of the Service's contribution to the fishing industry (and, hence, the Canadian economy) is that related to the fostering of an Atlantic herring fishery. In this connection, the Service undertook explorations of the availability of these stocks and subsequently promoted their exploitation by commercial interests. As a result, the value of this catch tripled, in the years 1962 to 1967, to a current annual value of approximately $9,000,000. Similarly, the development of a mid-water trawling technique has permitted

previously inactive vessels to participate in the expanded herring fisheries; assures reduction plants of an ample continuous supply of herring; and provides for increased earnings by plant workers.

The Service has also shared responsibility for the significant advances that are taking place with respect to the modernization of fishing vessels, gear, methods, and techniques which, as comparisons of fish landings show, have increased efficiencies.

While the Service has been associated with too many projects over the period of the last five years to detail them herein, the following are regarded as being representative.

- one of the largest mechanical dryers in the world has been developed to replace the traditional outdoor curing methods employed in the salt cod industry, thereby improving the product by eliminating the substantial adverse effects of variations in the ambient conditions.
- in cooperation with the Fisheries Research Board, advances have been made with respect to methods of employing refrigerated sea-water aboard fishing vessels for the purpose of improving the quality of such products as scallops, salmon, halibut, and tuna.
- an experiment, initiated at Miminegash, Prince Edward Island, in 1966, for the purpose of developing methods of extracting commercially valuable products from marine plants, has been so successful that private industry is now substantially expanding its operations throughout the Atlantic provinces.

- improvements effected in a mid-water trawl which was designed by a staff member have resulted in increased catches of herring and off-bottom ground fish.
- the establishment of a queen-crab industry on the Atlantic coast has resulted in a steadily increasing output of this high-price product (500,000 pounds in 1967), the basis of which, until recently, was regarded by the industry as being only a nuisance; and explorations are therefore continuing with a view to locating new stocks, and developing improved methods for catching them.
- the development of a new-type trawl for use in the Lake Erie smelt fishery has substantially increased the annual production of this species from 6,000,000 pounds in 1960, to an average of 15-million pounds in the 1961-67 period.
- introduction of the Scottish seine-net technique for harvesting groundfish, coupled with the appropriate education of fishermen in matters relating to its efficient use, facilitated the reactivation of usable vessels which were too under-powered to be employed as stern-trawlers.

While the Service, to date, has been fully occupied with immediate problems because of the industry's obsolescence, particularly in parts of the Atlantic coast region, it is foreseen that, as the industry continues to modernize, it will be less dependent upon the technical assistance afforded by the Service in connection with matters of a more-or-less routine nature; and that the Service will therefore be able

to devote more attention to long-term investigations of a more scientific nature. Such programs are essential if Canada is to compete with other nations in the exploitation of off-shore stocks, which, because of their close proximity, place the Canadian fishermen in the most favourable geographical position to harvest them.

If Canada's fishing industry does not modernize, its position with respect to world markets for fisheries products will be in peril because of the impetus being given to such measures by many other countries, which, through the introduction of modern fishing fleets, factory ships, refrigeration vessels, and other technological advancements will "out-fish" Canadians, and they will be able to market a superior product for less cost.

INTERNATIONAL FISHERIES SERVICE

Canada, as a member of nine international commissions and one international council, cooperates with many other nations in the collection and analysis of scientific data pertaining to living marine resources of common concern.

These international agencies have been established under the provisions of formal Conventions and, in general, they are responsible for the compilation of scientific data on which to base recommendations to the member governments for the management of specific resources in specific areas of the world.

A senior official of the Department of Fisheries serves on the executive body of each of these ten international organizations, only three of which employ scientific staff for the purpose of undertaking investigations. In all other instances, the organizations only plan and coordinate scientific investigations which are cooperatively undertaken by the appropriate national scientific agencies.

The Fisheries Research Board of Canada and, on occasion, the Department's Resource Development Service, assume responsibility for undertaking the research which constitutes the Canadian scientific input to these international organizations.

Pertinent facts concerning these international bodies are set forth hereunder

- The Convention for the International Council for the Exploration of the Sea, which dates back to 1902, was formed to encourage and coordinate investigations into the study of the sea, and, particularly, all of its living resources. The Council therefore promotes and organizes research in this field, draws up programs and disseminates results by means of publications. Its particular area of competence, which is the Atlantic Ocean and adjacent seas, primarily the North Atlantic, has resulted in membership of the following nations: Belgium, Canada (since 1967) Denmark, Finland, France, Federal Republic of Germany, Iceland, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Spain, Sweden, United Kingdom, and the U.S.S.R.

- The Interim Convention on Conservation of North Pacific Fur Seals was signed in 1911 for the purpose of coordinating the research of the member nations (Canada, Japan, the United States, and the U.S.S.R.) with respect to studies of fur seals in the North Pacific Ocean, particularly those directed toward maximum sustainable yield, sealskin quality, and the effectiveness of various sealing methods.

- The Convention for the Preservation of the Halibut Fishery of the Northern Pacific Ocean and Bering Sea, which was signed by Canada and the United States in 1923, with the objective of developing and maintaining the maximum

sustainable yield of halibut resources in the Bering Sea and the North Pacific Ocean adjacent to the coasts of Alaska, Canada, and the northwest United States, including territorial waters. The Commission maintains its own scientific staff to conduct research and investigations on which to draw up regulations for approval by the two member countries.

- The Sockeye Convention between the United States of America and Canada, Amended by the Sockeye and Pink Salmon Fisheries Protocol to the Convention. This Convention between Canada and the United States dates back to 1930, while the Pink Salmon Protocol was signed in 1956. They are intended to protect, preserve, and extend the sockeye and pink salmon fisheries in British Columbia's Fraser River watershed and in the territorial and high seas off the river estuary. The Commission has its own scientific staff which carries out investigations with a view to advancing recommendations to the two member countries concerning environmental improvement measures, fisheries regulations, and equal apportionment of the catch by the fishermen of the two nations.

- The International Whaling Convention was implemented in 1931 for the purpose of conserving and developing whale stocks in all waters where these marine mammals are exploited, and the provisions of this Convention apply to catcher-boats, factory ships, and land stations. The duties of the Commission are to recommend and organize studies relating to whales and the whaling

industry; and to regulate the industry. Current member nations are Argentina, Australia, Canada, Denmark, France, Ireland, Japan, Mexico, Netherlands, New Zealand, Norway, South Africa, United Kingdom, the United States, and the U.S.S.R.

- The International Convention for the Northwest Atlantic Fisheries, signed in 1949, has as its objective the wise use of all fishery resources of common concern in the Northwest Atlantic Ocean. The Commission therefore coordinates research; obtains and collates data concerning the conservation of stocks; and advances recommendations for joint action by the member countries, which are Canada, Denmark, France, Federal Republic of Germany, Iceland, Italy, Norway, Portugal, Poland, Romania, Spain, the United Kingdom, the United States, and the U.S.S.R.

- Convention for the Establishment of an Inter-American Tropical Tuna Commission, in which Canada became a member nation in 1968, originated in 1949; other members are Costa Rica, Mexico, Panama, and the United States. The broad objective of the Convention is the maintenance of the maximum sustained yield of species taken by tuna fishing vessels, but more particularly, it is directed principally toward yellow-fin and skipjack tuna in the eastern tropical Pacific Ocean, off the coasts of North and South America, between 40° N. and 30° S. The Commission maintains its own scientific staff which conducts investigations; studies and appraises data; recommends to the member nations proposals for joint action to maintain the maximum sustained yield; and publishes and disseminates reports and data.

- The International Convention for the High Seas Fisheries of the North Pacific Ocean was signed by Canada, Japan, and the United States in 1953 for the purpose of promoting and coordinating scientific studies, looking to the advancement of recommendations for conservation measures as they relate to the maintenance of maximum sustained productivity of all fishery resources, including salmon, halibut, herring, king crab, and other important species in all extra-territorial waters of the North Pacific Ocean and the adjacent high seas. The Commission studies the conditions of the various stocks; recommends to the member nations measures for ensuring continued productivity; and obliges member nations to refrain from exploiting the stocks of another member nation whenever the latter is fully utilizing and conserving them.

- The International Convention for the Conservation of Atlantic Tunas was agreed to in 1968 during the course of negotiations in which 17 nations participated. This Convention is now in force, and the Commission, which will be established at an early date, will endeavour to maintain the maximum sustained yield of tunas and tuna-like fishes in the Atlantic Ocean by coordinating studies and advancing recommendations for joint action by the contracting nations.

- The Convention on Great Lakes Fisheries, which was signed by Canada and the United States in 1955, seeks to control the sea-lamprey populations which

prey on the fish populations of the Great Lakes; and to coordinate research. The Duties of the Commission are to formulate research programs; to determine the need for measures directed toward attainment of maximum sustained productivity, and, if necessary, to undertake the research; to recommend appropriate measures to the member nations; to formulate and implement a comprehensive program which will control the sea-lamprey populations; and to publish scientific and other information.

APPENDIX 18

SUBMISSION OF THE MINISTRY OF FISHERIES

TO THE

SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

PART II: FISHERIES RESEARCH BOARD OF CANADA

DECEMBER
1968

SUBMISSION OF THE MINISTRY OF FISHERIES

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December, 1968
OTTAWA

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MINISTRY OF FISHERIES

PART II

FISHERIES RESEARCH BOARD OF CANADA

1. SUMMARY OF MAIN CONCLUSIONS AND RECOMMENDATIONS

1.1. The 18 member Fisheries Research Board, consisting of honorary representatives of science in universities, practical people from industry and representatives of the Department of Fisheries, provides knowledgeable and effective guidance to solution of scientific problems which affect Canada's national welfare and her competitive position in international fisheries.

1.2. The permanent Chairman of the Board implements policy decisions of the Board through general directives to the Directors of 8 research stations at strategic locations across the country. The current total scientific establishment of these stations stands at 258.

1.3. After more than 60 years of experience in conducting scientific research on the aquatic resources, marine and freshwater environments and fisheries of Canada, the merits of a research BOARD within the Fisheries Ministry have been amply demonstrated. Aside from having established a good reputation for advancement of scientific knowledge generally, the Board has provided valuable assistance to various services of the Department of Fisheries and to the fishing industry.

1.4. The Government of Canada must assume a dominant role in fisheries research in view of the common proprietary rights to the resources and the fragmented nature of the fishing industry. In this unique situation the Board dominates the Canadian fisheries research scene and possesses the broad spectrum of competence necessary to meet the government's numerous domestic and international obligations.

1.5. Current Fisheries Research Board activities may be broadly defined under five categories : The ENVIRONMENT, the RESOURCE, INCREASING THE RESOURCE, HARVESTING AND MANAGEMENT and COMMERCIAL PRODUCTS.

1.6. Each of these areas must be broadened and increased if Canada is to exploit its renewable common-property aquatic resources effectively. However, some areas require special attention during the years immediately ahead, and a corresponding large increase in staff and facilities :

(a) The special talents of FRB must be given the opportunity and scope for development in respect to the urgent inter-departmental assault on freshwater and marine pollution.

(b) In the face of ever increasing competition from foreign nations, it is vital that studies be expanded to develop utilization of poorly understood resources and reduce the cost of fishing for those resources which are already well utilized, particularly those over which Canada can maintain her sovereignty.

(c) Work should increase to assure solution of vexing problems which continue to stand in the way of effective positive measures to increase the supply of our most valuable species such as lobsters, oysters and salmon.

(d) Again in response to mounting international competition, more research must be directed to the study of fish behaviour to provide a sound biological basis for development of new apparatus, techniques and tactics to increase the efficiency of our fishing industry.

1.6. cont'd.

(e) Likewise, increasing competition at the international market place calls for increased work on the improvement of quality of existing products and the development of new products from the great variety of organisms and compounds available in the sea.

(f) In viewing these requirements, particularly respecting anti-pollution research, the base of the Board's responsibilities must be broadened -- beyond the sole consideration of fish and fisheries -- to include a large and active share in the responsibilities for water resources generally.

(g) Closer collaboration with universities is essential, not only to assure the continued supply of talented recruits to fisheries research but also to encourage active participation by universities in studies fundamental to the understanding of fishes and their responses to environment. .

(h) To meet the expanded requirements and broadened base of fisheries research, the Board foresees the need to increase "wet" laboratory facilities, experimental tanks, etc. and also to build up a fleet of modern research vessels to conduct FRB work and to supply the needs of university scientists.

(i) It is recognized that in order to meet the expanded responsibilities annual expenditures must be at least doubled during the next decade even if the effort to be expended were, as is desired, limited to uniquely Canadian fields where outstanding achievements are most likely to emerge.

2. CONTENTS OF THE SUBMISSION BY THE FISHERIES RESEARCH BOARD OF CANADA

2.1. ORGANIZATION

(a) THE BOARD

(i) The Fisheries Research Board of Canada is the oldest government supported independent scientific board in North America. Since its creation in 1898 it has been known by several titles and received its present name by Act of Parliament in 1937. From small beginnings and pursuant to several amendments to the FRB Act, it has broadened in scope and undergone changes in organization.

(ii) In its present form (as amended in 1953) the Board consists of a full-time Chairman and up to eighteen honorary members appointed by the Minister for 5-year terms of whom at present 10 are university scientists, 7 are individuals selected from the fishing industry and one an appointee from the Department of Fisheries.

(iii) The membership of the Board is divided into three Regional Advisory Committees -- Eastern, Central-Arctic and Western -- which meet once or twice annually with directors of FRB establishments (representing the staff of the Board, reviewed under 2.1.(c) below) and regional directors of the Department to review proposals and budgets and to adjudicate regional priorities.

(iv) An Executive Committee consisting of representatives of the Regional Advisory Committees, the Chairman and the Deputy Minister as an ex officio member establishes national priorities.

2.1.(a) cont'd.

(v) The full Board, at its Annual Meeting, receives reports from its committees and develops national policies. The organization of these and other committees of the Board itself (as distinct from its scientific or working level units), appears in Chart No. 1. National policy recommendations for government action are submitted to the Minister of Fisheries through the Deputy Minister. Recommendations not constituting change in national policy are handled through the Chairman to the Directors of the Board's research establishments.

(b) FORMAL CONNECTIONS WITH OTHER FEDERAL AGENCIES

For present purposes the Board's connection with other Federal agencies appears in diagrammatic form in Chart No. 2. Details on the actual roles played in these associations appear under Section 2.2.(c),below.

(c) ORGANIZATION OF UNITS - THE BOARD ESTABLISHMENTS

(i) Proposals for FRB research orginate in many ways: from outside agencies in requests to the Ministry; from the Ministry itself and from the Advisory Committees of the Board. Most research proposals however originate from the Directors of Board establishments which have charge of operational practices and responsibility for scientific activities. The establishments may, where appropriate, determine research activities through direct formal liaison with other agencies of the Ministry, universities or international agencies (see 2.1.(d), below).

(ii) The Board UNITS include regional establishments and Ottawa responsibility centers. (Chart No. 3).

CHART Nº1

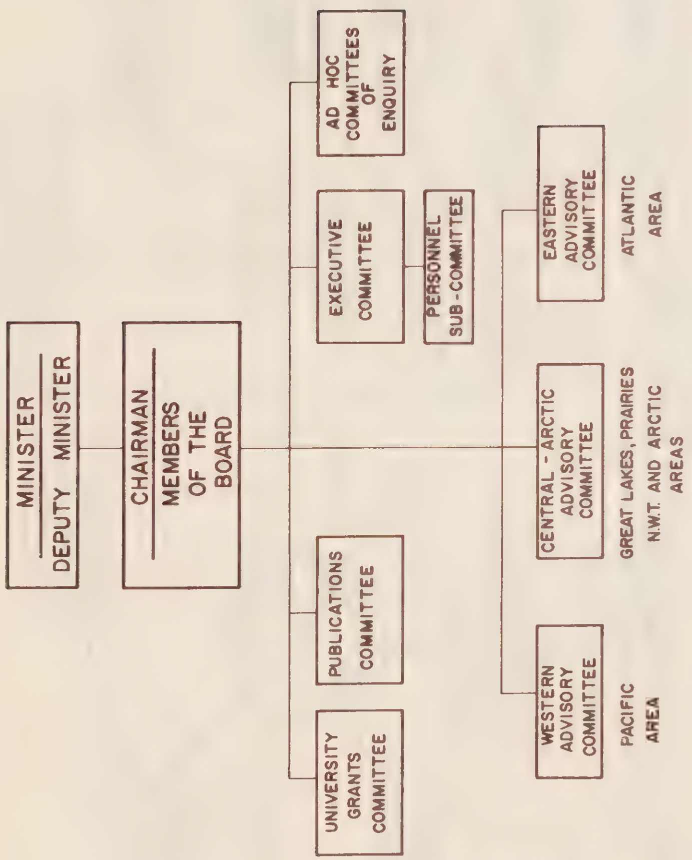

MINISTER
DEPUTY MINISTER
CHAIRMAN
MEMBERS OF THE BOARD
UNIVERSITY GRANTS COMMITTEE
PUBLICATIONS COMMITTEE
EXECUTIVE COMMITTEE
PERSONNEL SUB-COMMITTEE
AD HOC COMMITTEES OF ENQUIRY
WESTERN ADVISORY COMMITTEE
PACIFIC AREA
CENTRAL - ARCTIC ADVISORY COMMITTEE
GREAT LAKES, PRAIRIES N.W.T. AND ARCTIC AREAS
EASTERN ADVISORY COMMITTEE
ATLANTIC AREA

CHART Nº 2

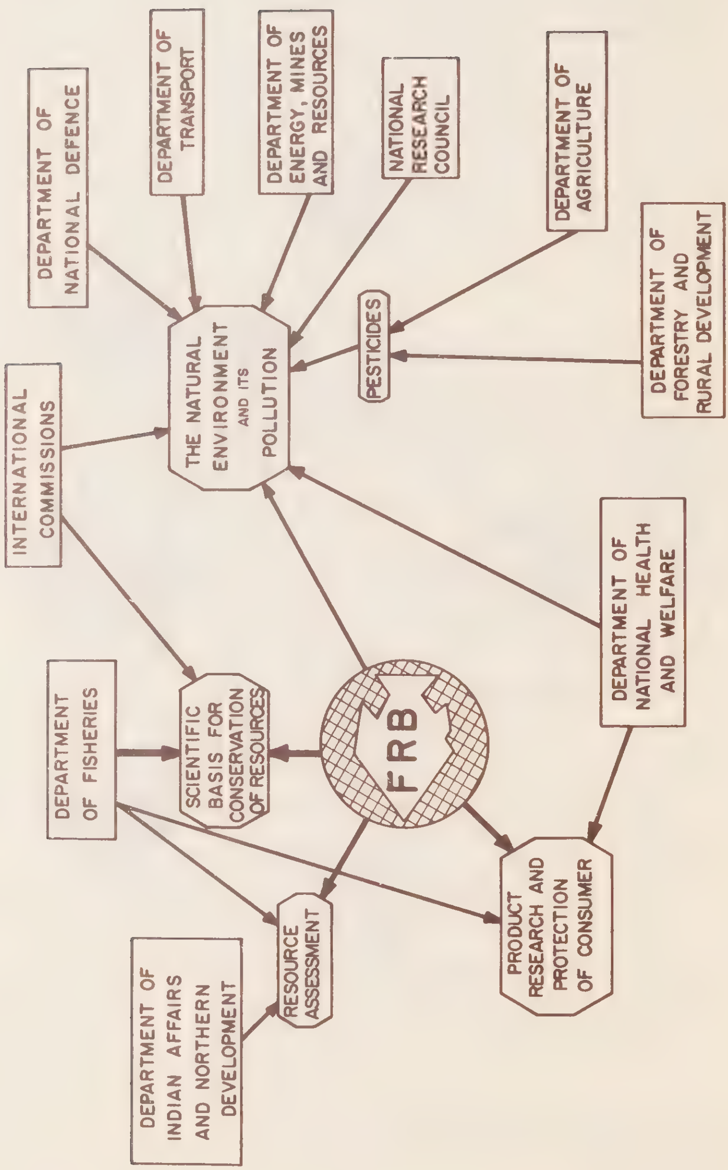
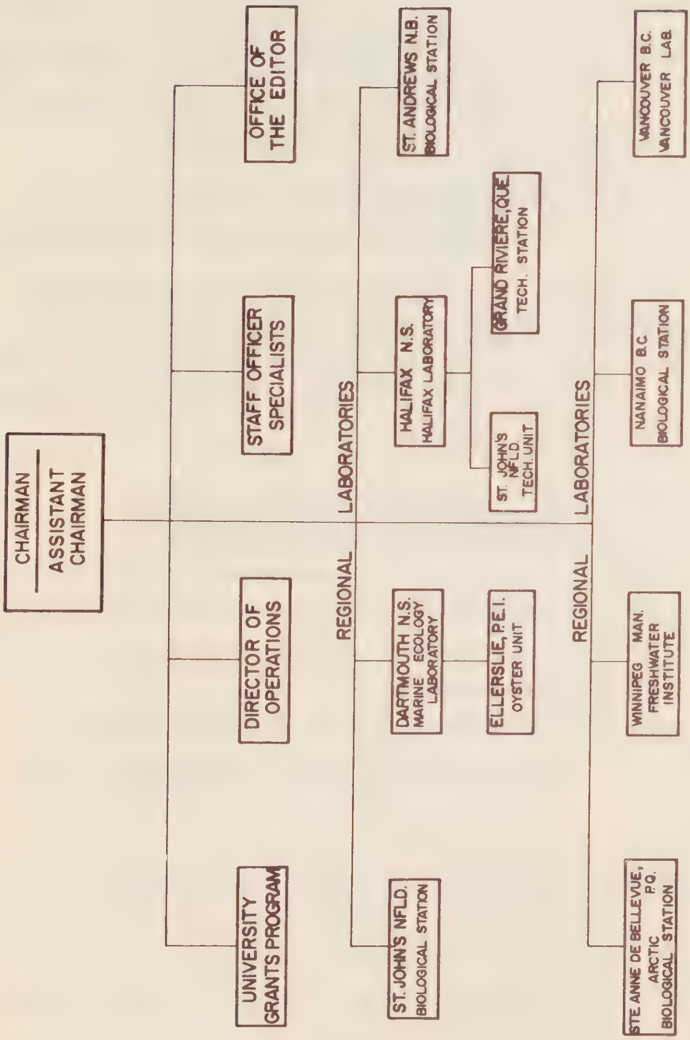

DEPARTMENT OF NATIONAL DEFENCE
DEPARTMENT OF TRANSPORT
DEPARTMENT OF ENERGY, MINES AND RESOURCES
NATIONAL RESEARCH COUNCIL
DEPARTMENT OF AGRICULTURE
DEPARTMENT OF FORESTRY AND RURAL DEVELOPMENT
PESTICIDES
INTERNATIONAL COMMISSIONS
THE NATURAL ENVIRONMENT AND ITS POLLUTION
DEPARTMENT OF NATIONAL HEALTH AND WELFARE
DEPARTMENT OF FISHERIES
SCIENTIFIC BASIS FOR CONSERVATION OF RESOURCES
FRB
PRODUCT RESEARCH AND PROTECTION OF CONSUMER
RESOURCE ASSESSMENT
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

CHART Nº 3


CHAIRMAN
ASSISTANT CHAIRMAN
OFFICE OF THE EDITOR
STAFF OFFICER SPECIALISTS
DIRECTOR OF OPERATIONS
UNIVERSITY GRANTS PROGRAM
REGIONAL LABORATORIES
ST. ANDREWS N.B. BIOLOGICAL STATION
HALIFAX N.S. HALIFAX LABORATORY
GRAND RIVIERE, QUE. TECH. STATION
ST. JOHN'S NFLD. TECH. UNIT
DARTMOUTH N.S. MARINE ECOLOGY LABORATORY
ELLERSLIE, P.E.I. OYSTER UNIT
ST. JOHN'S NFLD. BIOLOGICAL STATION
REGIONAL LABORATORIES
VANCOUVER B.C. VANCOUVER LAB.
NANAIMO B.C. BIOLOGICAL STATION
WINNIPEG MAN. FRESHWATER INSTITUTE
STE. ANNE DE BELLEVUE, P.Q. ARCTIC BIOLOGICAL STATION

2.1.(c) (ii) cont'd.

The Board is unusual among comparable agencies in not having laboratories in Ottawa. The Ottawa staff of the Office of the Chairman has been kept small, with substantial authority and accountability delegated to Laboratory Directors. Decentralization is considered essential for a proper research environment which, in turn, determines whether the FRB can attract and hold good scientists.

(iii) Within each unit there are sub-divisions based either on the kind of activity or particular subject. Biological Laboratories are divided according to species being investigated; others by ecological units (e.g. biological oceanography) or by discipline (biochemistry, engineering, mathematics, bacteriology, etc.).

(d) FORMAL AGREEMENTS WITH ORGANIZATIONS OUTSIDE OF CANADA REGARDING SCIENTIFIC ACTIVITIES

With few exceptions formal agreements regarding activities between the Board or one of its working units with organizations outside of Canada have developed from commitments made in the national interest by the Ministry in the course of international negotiations or in Federal-Provincial discussions. The Board participates in varying degrees by provision of scientific advice and/or data to commissions created by 6 multi-nation conventions; 5 conventions between Canada and the United States alone and to one of the special working committees of the Food and Agriculture Organization of the United Nations. Names of the organizations involved and the extent of FRB participation are detailed in Appendix I.

2.2. ORGANIZATIONAL FUNCTIONS OF THE BOARD

(a) STATUTORY FUNCTIONS AND POWERS

Under the Fisheries Research Board Act (1937, C.31,S.6) the Board's statutory functions and powers are defined as follows :

> "The Board has charge of all Dominion fishery research stations in Canada, and has the conduct and control of investigations of practical and economic problems connected with marine and fresh water fishes, flora and fauna, and such other work as may be assigned to it by the Minister."

In this original wording, and as originally intended, the government of Canada delegated its primary responsibility for the aquatic environment and life therein to the Fisheries Research Board of Canada. For many years it was the only organization in the federal government with scientific research responsibilities in this field. Subsequently, new agencies have been created by the Government to deal with special problems as they arose. Where responsibilities overlap, the FRB may participate in the research or, to avoid duplication, its existing activities may be co-ordinated as required. For further details of enabling legislation see Part III for statements regarding the BNA Act and the Department of Fisheries Act. (R.S.C., 1952, Chapter 69).

(b) ORGANIZATIONAL POLICIES AND THEIR BEARING ON SCIENCE POLICY

(i) Two unique features of the aquatic environment and its resource have considerable bearing on research policy. Firstly the sea and the large freshwater lake and river systems are common property resources whose non-proprietary users have no commercial incentive to invest in the

2.2.(b) (i) cont'd.

husbandry of their wealth and potential. For this reason and because of the fragmented nature of the fishing industry, there is no real alternative to government sponsorship of fisheries research. Secondly, Canada is bounded by three oceans and possesses the largest area of lakes and rivers of any country in the world. In the oceans, Canada has a special interest in the resources of the continental shelf and of the waters beyond. To stake her claims to these resources she requires the strong support of fisheries science. The Board has an important role to play in this regard, by developing the scientific background for full utilization of fisheries resources and for preservation of the quality of the aquatic environment for generations to come.

(ii) In the sea, many mysteries remain concerning the factors which govern the supply of animal protein. It exists in a multitude of forms, some utilized and some not, which are subject to large variations in availability. It is the task of fisheries science to understand and forecast these phenomena as well as to predict behaviour of the fish and thus improve on methods of capture. At the production level fisheries science must assist in the development of new products, new techniques of processing and preservation. In the sea, but particularly in freshwater there is an ever mounting urgency for solution of the problems of pollution. Not only are valuable freshwater anadromous fisheries being lost but more important, the water itself may be lost as a social and economic resource. In this field the Board can make a significant contribution.

2.2.(b) cont'd.

(iii) Naturally the major client of the Board is the Department of Fisheries which depends in various ways on the activities of the Board and thus influences its general policies. The Department is dependent on a sound biological background to implement the conservation of fisheries resources. Sixteen or more nations fish the Western North Atlantic adjacent to Canada and at least four are fishing the Eastern North Pacific. To provide management and conservation there have been several treaties under which International Commissions have been established. The FRB provides research and scientific advice to Canadian delegations for most of these bodies. Within Canadian waters many of the domestic conservation regulations for important fisheries such as those for lobsters, salmon, herring and oysters are based partly on information supplied by FRB research. In fact, FRB research plays a role, directly or indirectly, in the management of all marine commercial fisheries in Canada as well as sport fisheries in the Atlantic region. Much useful information is in turn derived by FRB scientists from activities of the Department of Fisheries.

(c) FUNCTIONS AND RESPONSIBILITIES IN RELATION TO OTHER AGENCIES AND ORGANIZATIONS

(i) As illustrated under 2.1.(b), above, the Board has important formal connections with at least 8 other Federal agencies. The policy behind these associations encourages exchange of information on subjects of mutual concern and the provision of advice to other Departments in such situations where the FRB is best qualified to do so. The associations are as follows :

2.2.(c) (i) cont'd.

(1) Department of National Defence. The Board has a strong interest in oceanography which defines the environment of the fisheries. Oceanographic research has produced information on such topics as the structure and behaviour of water masses which are equally relevant to fish behaviour and to submarine warfare. Since World War II the Board and Maritime Forces have cooperated in oceanographic research. The Forces have provided and operated a full time oceanographic research ship in each of the Atlantic and Pacific Oceans and additional ships and aircraft where required. In turn the Board has provided scientific personnel, shore laboratories, instruments, developed new instrumentation, and interpreted oceanographic data for the military as well as fisheries. The Forces operate oceanographic information services on both coasts in the form of charts, reporting on sea surface temperatures and related phenomena, which are made available to military and fisheries users. The Board and the Department are also dependent on Maritime Forces information services for information on the activities of foreign fishing fleets. Federal inter-agency cooperation in oceanography is coordinated by the Canadian Committee on Oceanography.

(2) Indian Affairs and Northern Development. A 1953 Bill gave this Department responsibility for coordinating all government activities in the Northern territories. The Board offers research and advice on the productivity of northern waters and the sustaining capacity of lake fish stocks for Eskimo and Indian settlements.

2.2.(c) (i) cont'd.

(3) National Health and Welfare. The Board has connections with this Department in advisory capacity on problems concerning protection of the health of consumers, such as research on shellfish toxicity, botulism, food colours and additives, product quality control.

(4) Department of Agriculture. Connections here are mainly concerned with pesticides and their effects on fishes, work being coordinated through the Federal Interdepartmental Committee on Pesticides.

(5) Forestry and Rural Development. Through the Interdepartmental Committee on Forest Spray Operations, the Department of Forestry and Rural Development has cooperated with the Ministry (and the Board) in improving the fishery situation in infested areas being sprayed with insecticides.

(6) Department of External Affairs. The Board, indirectly by way of the International Fisheries Service of the Department provides active scientific support, or advice, in international conservation and other fishery conventions. Also through the Ministry the Board has been involved in The International Joint Commission where fisheries problems are associated with international studies: e.g. Passamaquoddy Tidal Power Project, Great Lakes Pollution Study.

(7) Department of Energy, Mines and Resources. The Board, through the Department, is cooperating with the Inland Waters Branch of DEM & R, National Health and Welfare and other Departments in planning of a national water pollution control program.

2.2.(c) (i) (7) cont'd.

Work is being coordinated by the Interim Interdepartmental Committee on Water Programs. The Board establishments have frequently been consulted on the matter of regulating and monitoring of seismic and oil explorations which could seriously affect fisheries resources. Close connections are maintained with the Marine Sciences Branch of DEM & R in respect to physical oceanography. Board establishments play an active part in planning of physical oceanographic programs.

(8) Department of Transport. The Marine Services Division of this Department allows physical and biological oceanographic observations to be made by Board personnel from weatherships and Arctic icebreakers. Also, it is through the valuable assistance of this Department that monitoring of the marine environment is maintained by daily seawater observations along the East and West Coasts of Canada.

(9) Interim Interdepartmental Committee on Water Programs. In 1966 the Prime Minister designated the Minister of Energy, Mines and Resources to "take a leading role in formulating and coordinating programs concerning water in Canada." DEM & R proposes a Canada Water Act which is to provide coordinating machinery at federal and federal-provincial levels. Meanwhile, (1967) Cabinet has authorized the Interim Committee which, with its several sub-committees, is coordinating the work of federal agencies. The principal topic is water pollution control for which the principal legislation is the Fisheries Act and in which the Department of Fisheries and the Board have been active for many years, within the limitations of their budget allotments. The Ministry of

2.2.(c) (i) (9) cont'd.

Fisheries took the lead in the committee in presenting an adequate integrated, inter-departmental program of anti-pollution research and pollution control suited to Canadian economy, public desires and government policy.

(10) Other Agencies of Government. Scientists of the Fisheries Research Board have on various occasions served on committees formed by the National Research Council, e.g. Canadian Committee on the International Biological Program and its subcommittees, Associate Committee on Water Pollution Research, Associate Committee on Geodesy and Geophysics, Marine Sciences Committee.

(ii) Since 1924 representatives of the fishing industry have been active members of the Fisheries Research Board. Concurrently laboratories were established for the development, in close collaboration with industry, of improvements in the preservation and processing of fish, and of new products from fish. The biological search for new stocks of fish to be exploited, and for means of increasing stocks of lobsters, salmon, oysters, etc., is also of direct use to industry.

(iii) In its relations with educational institutions, the Board has on occasion made its ships, laboratories and field stations available for research by qualified academics. Since 1965 it has operated a modest grant program designed to assist certain university departments to improve the opportunities for graduate students to undertake theses concerning aquatic sciences. This policy regarding university support, though still

2.2.(c) (iii) cont'd.

in its early stages of development, has the particular aim of producing much needed recruitment of trained personnel with a bias towards renewable aquatic resources. The FRB is a unique interdisciplinary organization which unites experience and motivation in diverse sciences for the benefit of fisheries and water resources generally. It is important that universities be equipped to provide the necessary graduate training and that students be encouraged to accept the challenge presented by fisheries research. The policy of the Board to strengthen its relationship to universities has a number of purposes: to increase the supply of high quality graduate students oriented towards FRB activities and make them aware of the material and intellectual possibilities of employment by the Board; to increase within the universities active research in fields of interest to the Board; to gain intellectual stimulus arising out of specialist consultation; and to encourage direct cooperation on research projects between Board and university staff or graduate students. A full statement of the Board's policy with respect to educational institutions appears as Appendix II to this brief.

(iv) International representation and monitoring of scientific activities outside of Canada. The Board endeavours to encourage its scientific personnel to attend meetings of life science societies or organizations at frequent intervals. In addition there are delegates who attend regularly the meetings of agencies outside of Canada with which there are formal relationships (Appendix I). However, one of the most effective means of keeping in touch with scientific developments

2.2.(c) (iv) cont'd.

outside the country is through the library services. At the Board's laboratories it is common practice to distribute regularly, accession lists of publications which have been received by the library. Occasionally visiting scientists from allied agencies give lectures or seminars.

(d) REVIEW AND REVISION OF OPERATIONAL EFFECTIVENESS

At least once a year and frequently twice a year the Regional Advisory Committees (2.1.(a)) have opportunity to scrutinize programs presented by Directors of Laboratories and also to make recommendations to the Executive Committee for additions, deletions or changes in emphasis. Because the Board includes representatives of the fishing industry as well as the academic community, there are built-in safeguards which prevent excessive drift away from topics of practical reality and, at the same time, protect necessarily long-range and fundamental studies from the pressing but sometimes ephemeral demands for quick answers. This balance of influences has done much to ensure the quality, reliability and national interest of the research, and to preserve the kind of research environment which attracts and holds talented scientific personnel.

(e) OUTSIDE STUDIES OF OPERATING PROCEDURES

(i) In the sense that outside studies are regarded to be those conducted by consultants in response to directives outside the Ministry, there have been no such studies within the past 5 years. Within the Ministry, the Board has sought the services of management analysts who, over the past several years, have studied and made recommendations on administrative procedures at the Ottawa Headquarters as well as at several of the regional laboratories.

2.2.(e) cont'd.

(ii) To the extent that an agency's operating procedures may include the organization of research staffs for an attack on a particular problem, the Board itself may recommend inquiries which, in effect, are commissioned "outside" or above the level of units responsible for scientific activities. As an example, a recent situation may be cited in which the Western Advisory Committee expressed concern about the organization and coordination of research on salmon being conducted by the Board and the Resource Development section of the Ministry. The outcome of this enquiry was a clarification of (a) areas of ignorance which frustrate a rapid, but at the same time, sound assault on the problem of salmon enhancement, and (b) avenues of research most likely to provide useful results.

(f) RESPONSIBILITIES AND POWERS VERSUS ACTIVITIES AND PROGRAMS

(i) The Fisheries Research Board Act provides sweeping authority to conduct and control federal investigations seemingly of all problems "....connected with marine and freshwater fishes, flora and fauna ...." which are under jurisdiction of Canada (as provided by the BNA and Fisheries Acts). However, problems unforeseen at the time the FRB Act was passed by Parliament have now assumed such magnitude (e.g. freshwater and marine pollution) that new agencies have been created and others given extended terms of reference to search for solutions. Recently (1966) DEM & R was assigned the responsibility to coordinate these activities at the federal and federal-provincial levels (2.2.(c), above).

(ii) Despite these shifts in authority and sharing of responsibilities, the remaining areas of sole FRB responsibility have assumed increased diversity and complexity stimulated in part by the Ministry's broadened involvement in

2.2.(f) (ii) cont'd.

international fisheries matters. Consequently, the Board is hard pressed to meet its responsibilities, and can do so only by dropping or deferring projects in favour of those of greatest urgency. Currently, for example, expanded staffing and funding of research on new or enlarged programs, salmon enhancement, international commitments, etc. is being accomplished only by restriction of activities in other areas -- among which at the moment is anti-pollution research. If the Board is to contribute its unique expertise to solution of pollution problems, expansion to an effective level of operation will require additional funds, extra to the present budget level of the Board.

(iii) Most fields of FRB research are not covered in sufficient depth to have an optimal impact on the fishing industry or on science. There is still a communications gap with the industry, but nevertheless FRB could double or triple its effort before it could be described as meeting its present research commitments.

(g) HINDRANCES TO EFFECTIVE PERFORMANCE

(i) Agencies which deal with the renewable living resources of Canada (Fisheries and Forestry and Agriculture) are hard pressed to compete for attention (and the tax dollar) with the more obvious enterprises of medicine, space research and nuclear physics, to name but a few. Even within a more restricted field there is no question that fisheries runs a poor second to agriculture in practical accomplishments. One reason is the disparity in effort applied to the two fields. Because forestry and agriculture are provincial resources assigned by the BNA Act, most of the provinces in Canada have a major educational institution or government division devoted to training people for, carrying out research

2.2.(g) (i) cont'd.

and demonstrating its results in all aspects of agriculture. Many private companies devote large sums of money to effective research in agriculture, resulting in improved machinery, fertilizers, feeds, crops and methods. Research in fields not directly related to or connected with agriculture -- meteorology and climatology among others, make important contributions to agriculture. The gratifying progress in this field speaks well for the scientific approach and augurs well for what can be done if comparable well-planned research activity is achieved in fisheries. It must be acknowledged, however, that direct comparisons between fisheries and agriculture are not entirely appropriate. Much of the research expenditure by agriculture (and forestry) is directed to demonstration -- demonstration of tangibles which are far easier to come by than in fisheries. In any event, demonstration to individual fishermen (as compared to individual farmers) of means of increasing their harvest is at best a minor responsibility of FRB and one which is confounded by the common property feature of the resource.

(ii) One hindrance to effective performance of the Board's functions and the meeting of its responsibilities is the shortage of institutions from which multi-disciplined recruits may be drawn, and the lack of industrial investment in programs of research. The latter, of course, except in the case of product quality research, can hardly be expected where we are dealing with a fragmented industry and a common property resource. The recently established FRB Grants Program (2.3.(a)) is designed and hopefully expected to ensure a continuing supply of the kinds of research personnel required.

2.2.(g) cont'd.

(iii) Some aspects of fisheries research, particularly in the sea, and experiments in the natural environment, admittedly are far more expensive than "on land" research. Vessels are costly but necessary platforms and must be equipped with bulky, complex instruments to make observations and understand what otherwise on land would be a relatively simple task. A homely but nevertheless appropriate example is the imaginary situation of a forester bent on assessing the optimum conditions for forest management, but limited in his facilities to a helicopter equipped with some sensing device which must be lowered through an ever-present cloud bank. It is the unavoidable indirectness of much of the research on fishes and their environment which demands a disproportionately large outlay of funds in equipment and "platforms".

(iv) As exemplified by events in other countries, the problem of improving techniques of harvesting do not yield easily to research. The need for increasing the efficiency and hence decreasing the cost of harvesting places limits on the potentialities of engineering research. However, one of the main obstacles is ignorance of the behaviour of fish -- their response to the natural environment and their response to fishing gear. The cost of maintaining laboratories for experimental research on behaviour no doubt compares favourably with those of agriculture and other lines of research, but the history of success in translating laboratory observation into terms of the natural environment clearly indicates the inadequacies of prevailing research facilities and the dearth of professionally trained people in the field of animal behaviour.

2.2.(g) cont'd.

(v) Though substantial accomplishments have been made under relatively austere conditions, few of the Board's establishments provide the accommodation and laboratory facilities necessary to maintain Canada's sovereignty and her outstanding contribution to scientific knowledge. It is in the provision of completely modern salt and fresh water laboratories where Canada can readily establish world leadership.

(vi) In the field of product research, where Canada has been in the forefront of fish preservation, conservatism within the industry poses a hindrance to improvement of new products. In the international market place, Canada's competitive position with other exporting nations could be improved greatly by much greater technological research and demonstration geared to increasing quality and reducing costs of production and to introducing new and varied products to the consumer.

(h) FORECAST OF ORGANIZATION FUNCTIONS

The firm conviction of the increasingly important role of fisheries in the scientific development of Canada has prompted the Board to prepare a document THE FISHERIES RESEARCH BOARD OF CANADA AND ITS PLACE IN THE SCIENTIFIC DEVELOPMENT OF CANADA DURING THE NEXT DECADE, 1968-1978 (Appendix III). The abstract of that document, reads as follows :

"The Fisheries Research Board of Canada was created by Act of Parliament specifically to carry out government-sponsored research in fisheries and aquatic biology.

FRB research results are utilized extensively by the Minister of Fisheries in regulatory actions and in international agreements.

2.2. (h) cont'd.

Other Federal government agencies, Provincial governments, and universities carry out limited programs of fisheries research. Virtually no fisheries research is carried out by private industry. FRB dominates the Canadian fisheries research scene.

Present FRB research activities have been grouped into the categories shown below.

1. The Environment - achieving an understanding of what causes differences in aquatic productivity; investigating pollution.

2. The Resource - examining the body chemistry, life history, populations and production of economically valuable species.

3. Increasing the Resource - increasing the supply of salmon and shellfish by improved propagation techniques; reducing losses of live-held lobsters etc.; control of competitors or predators.

4. Harvesting and Management - locating new stocks; accessibility and behaviour of fish in relation to existing or new types of gear; obtaining information needed for management; forecasting stocks and catches.

5. Commercial Products - collaborating with industry to upgrade existing fishery products; developing or improving handling and preservation processes; determining factors that affect quality; developing new products from fish, invertebrates and micro-organisms.

2.2. (h) cont'd.

Each of these areas of fisheries research must be broadened and increased if Canada is to exploit its renewable common-property aquatic resources effectively. However, some areas require special attention during the years immediately ahead, and a corresponding large increase in staff and facilities. These include :

* anti-pollution studies, both freshwater and marine;
* studies to develop utilization of poorly understood resources such as fishes in the "deep scattering" layer of the ocean and to foresee alterations in availability of herring, capelin, and sand launce as large predators are fished out;
* work to increase the supply of particularly valuable species, notably lobsters, oysters, and salmon;
* understanding the implications of changes in stocks and in commercial interest as fishing becomes more intense (e.g. the need for alteration in apparatus, techniques and tactics for capture of smaller sizes of cod and other species whose behaviour pattern may be different);
* development of new products from the great variety of organisms and compounds available in the sea.

Some of these fields, particularly freshwater pollution, bear on national problems whose effects are felt considerably beyond the sphere of fish and fisheries.

2.2. (h) cont'd.

In planning new construction to meet these requirements, special attention needs to be given to increasing "wet" laboratory facilities, experimental tanks, etc., and also to building up an adequate fleet of ships to conduct FRB work and to supply the needs of university scientists."

2.3. PERSONNEL POLICIES

(a) IDENTIFICATION OF PROSPECTIVE RECRUITS

The policy of FRB is at all times to stress and encourage close contacts and liaison with university and faculty members who have research and teaching interests in Aquatic Sciences. The Board does not follow the practice of other Government Departments, or of the Public Service Commission, of sending interviewing teams to universities to seek prospective employees. Instead, where possible, personal year-round contacts are maintained between Board stations and university staff and students. In recent years, this has been supported by a developing University Grants Program which has been designed to fill the special needs of the Board. It was not thought wise or desirable to duplicate the excellent schemes already in existence but, preferably, to concentrate upon supporting a limited number of universities which have over the past years formed close contacts and associations with FRB; U.B.C., Manitoba, Toronto, Dalhousie and Memorial. In addition the Board is willing to receive proposals for joint supervision of graduate students from any Canadian university, and to place Board facilities at the disposal of these students. In cases where such mutually satisfactory agreements are concluded, the student's stipends are paid by the Board. During construction of new stations, the Board will take steps to provide laboratory space for the use of graduate students.

2.3. cont'd.

(b) CRITERIA TO IDENTIFY MOST EFFECTIVE RESEARCHERS

FRB has developed certain criteria (see Appendix IV), which cover all phases of its research operations, and which provide an adequate basis for assessing the progress of its research staff. In developing these guidelines, it has been understood that publication productivity is the most relevant tangible indication of scientific merit; however, bearing in mind the undue stress which might be placed on quantitative values as opposed to quality, this factor is reviewed in relation to the other relevant criteria in reaching the final assessment.

(c) POTENTIAL ADMINISTRATORS

In a decentralized operation such as that of FRB, it is essential that close personal contacts should be maintained between the purely administrative Office of the Chairman and the research stations. Through this liaison it is possible, in such relatively small organizations, to identify staff members with administrative interests and administrative potential. Assessment of individuals is accomplished by periods of secondment to Ottawa, or for specialized tasks coordinated by the Office of the Chairman. This program is supported, where necessary, by formal courses in specialized aspects of administration, though these are not used routinely as a means of assessment, but are regarded as providing additional training for staff of proven ability.

(d) DISTINCTIONS BETWEEN ADMINISTRATORS AND RESEARCHERS

(i) Research scientists and research administrators alike must possess the minimum qualification for entry into the scientific category. The Board's requirement for research administrators is relatively small; appointments are all at senior levels and are

2.3.(d) (i) cont'd.

confined to individuals with demonstrated research ability. In view of the limited number of staff holding these positions, classification into administrative categories has not been warranted, and for classification purposes they are scientists. However, in reviewing promotional changes consideration is given to criteria similar to those adopted for the Research Management Class of the Public Service Commission.

(ii) In addition to this purely administrative group, financial recognition of administrative responsibilities is given to some senior station staff, e.g. Directors and Assistant Directors, who are performing both research and administrative functions. This salary adjustment is terminable if the employee relinquishes his administrative responsibilities.

(e) EDUCATION FOR STAFF MEMBERS

Extramurally, the Board encourages staff members to improve their educational or research status by operating programs of educational and sabbatical leave (see Appendix V and VI), and by supporting financially individuals who wish to attend approved local courses of benefit to their work. The essential criterion for guidance in all these programs is the individual's potential for future development. There is no formally organized intramural educational program, though, as in all scientific research organizations, staff benefit from frequent seminars presented by FRB and visiting scientists. On occasions, where there has been a demand, workshops have been organized, but these have generally been at the sub-professional level.

2.4. DISTRIBUTION OF ACTIVITIES

(a) REGIONAL PATTERN OF EXPENDITURES

In large measure the regional distribution of the Board's research establishments is determined by their proximity to major fisheries and/or water resource areas. Regions particularly suited to research activities are those which are

2.4. (a) cont'd.

in close contact with the fishing industry and preferably near academic institutions.

(i) East Coast Regional Laboratories.

The Biological Station at St. John's, Nfld. in 1967-68 accounted for 10.0% of the Board's operating expenditures including 0.9% on technological research controlled from the Halifax (Technological) Station. This latter laboratory also coordinates the scientific program of the Technological Station at Grande-Rivière, Que. Also located on the east coast are the Marine Ecology Laboratory at Dartmouth, N.S. and the Biological Station at St. Andrews, N.B. These three laboratories account for 10%, 5% and 15% respectively, for a total of 40% of the Board's operating expenditures in the east coast region.

(ii) Central-Arctic Regional Laboratories

The Arctic Biological Station has its headquarters at Ste. Anne de Bellevue, near Montreal. Recently marine mammal research from our three oceans has been concentrated at this Station. Funds allotted to the Arctic Station account for 6% of the Board's expenditures. The Freshwater Institute is located at Winnipeg and is in the early stages of development. Funding currently amounts to 11% of the Board's expenditures.

(iii) West Coast Regional Laboratories

The Vancouver (Technological) Laboratory is situated on the University of British Columbia campus and the Nanaimo Biological Station is located on Vancouver Island. The budgets for these two west coast stations are 7% and 26% respectively, for a total of 33% of the Board's operating expenditures.

2.4.(a) cont'd.

(iv) Headquarters and Office of the Editor

The remaining operating expenditures are incurred in Ottawa where 3% was spent by the Office of the Chairman, 3% by the Office of the Editor and 4% on the university support program.

(b) SUITABILITY OF REGIONAL DISTRIBUTION

(i) In large measure the regional distribution of the Board's research establishments is determined by their proximity to major fisheries and/or water resource areas. Regions particularly suited to research activities are those which are in close contact with the fishing industry and preferably near academic institutions.

(ii) The St. John's Biological Station is at the doorstep of the world famous Grand Banks, while the Halifax (Technological) Laboratory, the Marine Ecology Laboratory at Dartmouth and the St.Andrews Biological Station are located close to other major fishing areas.

(iii) Logistically it is easy to service Arctic research from the Arctic Biological Station at Ste. Anne de Bellevue, near Montreal. Besides, Montreal is the headquarters of the Arctic Institute of North America. Recently marine mammal research from our three oceans has been concentrated at this Station. At Winnipeg, the Freshwater Institute is on the campus of the University of Manitoba and is centrally located for biological and technological research concerning Canada's inland lakes and rivers.

(iv) The Vancouver (Technological) Laboratory is situated on the University of British Columbia campus, but still

2.4. (b) (iv) cont'd.

close to major fish processing operations. The Nanaimo Biological Station is more removed from the regions of greatest fishing or processing activities, but is situated at a major communication centre on Vancouver Island. In any case, the location is not an important factor in the efficiency of operation. A high percentage of the research effort is expended on the high seas and in areas of the province remote from population centres and from the central laboratory.

(c) ACTIVITIES IN RELATION TO REGIONAL PROBLEMS

Among the three regions of the country serviced by the Board, the biological problems and general techniques of investigation differ substantially, largely because of the differing importance of the animals which contribute to the fisheries economy of each region. Technological problems in the three regions have more in common, but again, the emphasis of the Board's activities is dictated at least in part by the species composition of the major fisheries. A review of activities carried out regionally by the Board during the past five years has been reserved for Section 2.9, below.

(d) ACTIVITIES IN RELATION TO REGIONAL DEVELOPMENT

(i) One of the major problems confronting the establishment or expansion of biological laboratories is the difficulty of obtaining assured and uncontaminated supplies of fresh and salt water. This has been a matter of considerable concern in arranging for establishment of a third laboratory on the west coast to complement requirements of water laboratory facilities at the Vancouver and Nanaimo Stations, and become the centre for west coast pollution research.

2.4. (d) (i) cont'd.

Such an establishment presumably would provide information valuable in long-term planning of urban and regional development. At the same time the region as a whole would benefit from opportunities for closer collaboration with universities.

(ii) The Board's role in regional development is at best an indirect one consisting mainly of provision of scientific advice to the Ministry's Resource Development Branch on such subjects as Pacific and Atlantic salmon, and scientific direction to exploratory fishing operations funded by the Ministry's Industrial Development Service. The Board's modest university grants program established to encourage specialized regional educational facilities contributes indirectly to regional development.

(iii) The question of determining the optimum degree of decentralization or regionalization of Board activities although no doubt of considerable importance in other departments finds little relevance in fisheries research. Clearly, regional laboratories to keep in touch with reality must be close to or within the general problem area. The optimum size of laboratories is a question of much greater significance and one which is constantly before the Board when plans for expansion are under consideration. Improved communications make it possible to serve large areas from strongly manned central laboratories. Hence further decentralization of scientific activities *per se*, cannot be expected to make significant contributions to regional development.

2.5. PERSONNEL ASSOCIATED WITH SCIENTIFIC ACTIVITIES

(a) CURRENT PERSONNEL ESTABLISHMENT

As of October 1, 1968, the total FRB establishment was 855. Of these 269 were authorized scientific positions, with an actual strength of 231. Details by individual laboratory units, by degree categories, including information on the number of post-doctoral fellows may be found in Appendix VII.

(b) STAFF WITH ADMINISTRATIVE DUTIES

It is estimated that there are 21 out of the 231 professional staff who devote most of their time to administrative duties. (see Appendix VII).

(c) INFORMATION ON THE PROFESSIONAL STAFF

(i) Country of Birth. Most of the professional staff (55%) was born in Canada, while 80% originated either from Canada, the United States or the United Kingdom. The remaining 20% were mainly from continental Europe, the Middle East and Asia. For more detailed information on birth place by degree category see Appendix VIII.

(ii) Country in which secondary education taken. Staff who received their secondary education in Canada amounts to 60.8%. Over 82% received it either in Canada, the United Kingdom or the United States. (A more detailed breakdown by country and by degree held may be found in Appendix IX).

(iii) Country in which highest university degree taken. About 58% of the staff received their highest degree in Canada. The proportion from within Canada, the United Kingdom and the United States is about 89%. (see Appendix X for further details).

2.5.(c) cont'd.

(iv) Number of working years since graduation. Amongst persons holding a bachelor's degree only, the average number of years since graduation (as of September, 1968) is 14.0 years; for holders of a master's degree 13.2 years; for holders of a doctorate 13.5 years (details given in Appendix XI). Regarding the number of working years employees have been with the Board, the figures for holders of bachelor's, master's and doctorate degrees average 11.0 years, 10.2 years and 9.4 years, respectively. (details given in Appendix XI).

(v) Average age of professional employees. Among holders of a bachelor's degree the average age is 37.2 years; for holders of a master's degree 39.1 years; for holders of a doctorate 41.7 years. (details given in Appendix XI).

(vi) Percentage of personnel able to work effectively in Canada's two official languages. Out of a total of 32 holders of a bachelor's degree only one person (3.1%) claimed proficiency in the two languages. Among 69 master's degree holders there are 7 or 10.2%; while among 134 holders of a doctorate there are 14 or 10.4%. Disregarding categorization by degrees, the total who claim to be able to work effectively in both languages is 22 or 9.4%. Of the 22, the mother tongue for 4 is French, for 8 it is English and for 10 it is still another language. Regionally, exactly half of those claiming to be effective in both of the official languages are at laboratories west of Montreal. Of the total number of professional personnel 119 or 50% claimed facility in reading the French language. (for further details see Appendix XI).

2.5.(c) cont'd.

(d) TOTAL PROFESSIONAL PERSONNEL:
1962-68 AND FORECAST TO 1973

Between 1962 and 1964 the total number of personnel declined from 175 to 166. However, from 1965 to 1968 it rose steadily to 231. The total establishment (number of positions) actually stands at 258, the 27 unoccupied positions being currently frozen. In forecasting further growth, it has been assumed that the establishment will remain frozen at 258 into 1970 and that subsequent improvement in the national economy will permit growth to proceed at a rate commensurate with that predicted by the "PLANNING FOR THE NEXT DECADE" (Appendix III). Under these conditions it is anticipated that the scientific complement will have reached about 304 by 1973.(see Appendix XII).

(e) TURNOVER OF PROFESSIONAL STAFF

From 1962 to 1967 the proportion of personnel who resigned from the Board averaged 5.1% per year and ranged from 8.2% in 1963 to 3.3% in 1966. (Appendix XIII).

(f) EMPLOYMENT OF PERSONNEL IN OTHER FIELDS

(i) twenty-nine or 12.3% of the current professional personnel were at one time employed by the private sector of industry;

(ii) fifty-eight of 24.7% reported that they had at one time been employed by universities, while 35 or 14.9% had teaching experience and 53 or 22.5% had experience as supervisors of graduate students;

(iii) twenty-four or 10.2% had been employed by Provincial Governments;

(iv) twenty-six or 11.1% had been employed by other Federal agencies; and

(v) those who had at one time been employed by foreign countries or by international agencies such as FAO amounted to 44 or 18.7%. (see Appendix XIV for details bv laboratories or regions).

2.5. cont'd.

(g) NUMBER OF STAFF ON EDUCATIONAL LEAVE

As of October 1, 1968, there was one member of the FRB staff registered for a master's degree and 4 were registered for doctorates.

(h) SUMMER EMPLOYMENT OF UNIVERSITY STUDENTS

From 1962 to 1967 the numbers of university students employed by the Board rose from 87 to 168. For details by laboratories or regions see Appendix XV.

2.6. EXPENDITURES ASSOCIATED WITH SCIENTIFIC ACTIVITIES

(a) TOTAL FUNDS EXPENDED BY THE FISHERIES RESEARCH BOARD

(i) Expenditures by Function

Total expenditures by the Board in five functional categories are provided in Appendix XVI which summarizes more detailed information for individual years and individual units or laboratories in Appendices XVII to XXII. In the six year period 1962-63 to 1967-68 the total annual expenditures averaged $9.28 million, ranging from a low of $6.29 million in 1963-64 to more than double this figure ($14.5 million) in 1967-68.

(1) On the average it is estimated that 64.6% of the expenditures were made in INTRAMURAL RESEARCH AND DEVELOPMENT;

(2) 30.8% in DATA COLLECTION;

(3) 3.0% in SCIENTIFIC INFORMATION;

* (6) 1.4% in SUPPORT OF RESEARCH AND DEVELOPMENT IN UNIVERSITIES; and

(7) 0.2% in SUPPORT OF HIGHER EDUCATION.

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* The order of enumeration here and in succeeding paragraphs refers to the system recommended in the Senate Committee's GUIDELINE for preparation of this Brief.

2.6. (a) cont'd.

(ii) Expenditures by Scientific Discipline

In fisheries science there is much more interlacing of scientific disciplines than appears in the simplified presentation in Appendix XXIII. In the preceding 6-year period 59% of the total of the total expenditures (operating and equipment costs) were made in:

2(a) The BIOLOGICAL SCIENCES (zoology, ecology, physiology, parasitology, genetics, microbiology, bacteriology, etc., but excluding biochemistry).

2(e) The field of CHEMISTRY (physical and organic, plus biochemistry) the expenditure was 23% of the total;

2(h) OCEANOGRAPHY accounted for 11%;

(1) ENGINEERING AND TECHNOLOGY accounted for 7%.

Forecast expenditures for 1968-69 to 1973-74 within the above-mentioned disciplines are expected to remain proportionately the same as in the preceding 6-year period.

(iii) Expenditures by Areas of Application

The bulk of the expenditures in the preceding 6 years was directed to :

(4) Application by Canadian FISHERIES;

The remaining expenditure found application in the fields of :

(3) NATIONAL DEFENCE (oceanography);

(6) TRANSPORTATION (improvements in refrigeration and storage); and

(8) NATIONAL HEALTH (pollution research).

In the Board's own classification of areas of application (see 2.2.(h) above, for further details) the current expenditures and 10-year projections are apportioned as follows :

2.6.(a) (iii) cont'd.

	1967-68	1977-78
THE ENVIRONMENT	19%	22%
THE RESOURCE	29%	18%
INCREASING THE RESOURCE	16%	20%
HARVESTING & MANAGEMENT	24%	25%
COMMERCIAL PRODUCTS	12%	15%

By 1973-74, it is presumed that the transfer of emphasis will be at an intermediate stage. The most pronounced change in allocation of research effort will be in the reduction of work on the RESOURCE in favour of work on INCREASING THE RESOURCE and on the ENVIRONMENT. To illustrate, it is anticipated as a greater appreciation is gained of salmon physiology and behaviour at all stages of the life history, a foundation will be laid for effective positive measures to increase the resource in ways which were heretofore impossible for lack of the right kinds of knowledge.

(b) OPERATING AND CAPITAL FUNDS EXPENDED BY UNITS (RESEARCH ESTABLISHMENTS)

Total expenditures for the period 1962-63 to 1967-68 are shown in Appendix XXIV. For summary purposes Appendix XXV shows the total (operating and capital) expenditures consolidated and averaged by major regions -- Atlantic, Central-Arctic, Pacific. In this presentation research grants and scholarships, operating costs of the Office of the Chairman and costs incurred by the Office of the Editor are combined under "Headquarters". Average expenditures in the succeeding 6 years will have to be higher than in the past 6 years if the Board's planned objectives are to be met. Proportionately lower expenditures will be made on the west coast in favour of a substantial increase in the

2.6. (b) cont'd.

Central-Arctic region (primarily for the construction and development of the Freshwater Institute at Winnipeg). Construction of a new laboratory at St. John's, Newfoundland and provision of increased water laboratory facilities at other east coast research establishments account for increased emphasis in that region.

(c) EXPENDITURES ON EDUCATIONAL LEAVE

In 1962-63 there were two employees on educational leave and the Board's expenditure in this connection was $7,900. In 1968-69 the number of individuals on leave had increased to five and expenditures were $33,000 (Appendix XXVI). Some of the Board's laboratories are located in or near university cities, and some employees have been granted permission to take certain course work during or after regular working hours. Here there are no direct expenditures by the Board to further education of staff.

2.7. POLICIES RELATED TO RESEARCH ACTIVITIES

(a) UNITS CONCERNED WITH INTRAMURAL RESEARCH ACTIVITIES

(i) Selection, initiation and monitoring of programs

In Section 2.1.(c) of this Brief it was mentioned that proposals for research develop in numerous ways. Most arise at the regional laboratories where the Director prepares an outline of a program (with anticipated costs) for presentation to the Chairman of the Board. Other program proposals may come directly to the Chairman from the Ministry, from industry or from other sources outside the Ministry. The programs are then referred to the appropriate Regional Advisory Committee where the relative merits of new programs versus those already in existence are debated. The outcome of the discussion and of staff studies where necessary is a proposal to the full Board, usually emphasizing programs which are new and those which might be modified, reduced or reoriented, together with indications of the priorities. Here the programs are considered in light of the Board's general policies and principles. Recommendations are then directed to the Executive Committee for consideration in light of financial directives from the Treasury Board and selections are made from the list of priorities of those programs most likely to be effectively executed within the limitations of funds available. From there the Chairman of the Board, on behalf of the Executive Committee, issues the directives to the regional laboratory directors. Monitoring of the progress of approved programs is conducted at two levels - first by annual review of progress by program heads with the laboratory director and subsequently with the Regional Advisory Committee.

2.7.(a) cont'd.

(ii) Process of establishing and implementing priorities

(1) Establishment of priorities between programs and projects is a most arduous one, even at the regional level. There are no easy answers to be found in benefit/cost analysis, principally because the benefit, even if measurable in dollars, can be determined with accuracy only after the program has reached its research goal and passed to branches of the Department for application. Some of the programs are closely tied to the Ministry's involvement in establishing sovereignty claims on resources which are in danger of being depleted by foreign nations. The results of scientific research on such matters provide important assistance to the Department. However, the monetary benefit of such assistance is more hazardous to determine since it is difficult if not impossible to determine the relative roles which scientific evidence and political pressure play in reaching international agreements.

(2) By and large, it is recognized that the professional advisers (program heads, laboratory directors and headquarters specialists) are the technical experts, if only because they are faced with problems year-round. Members of advisory committees by contrast, can devote no more than a few days per year to their responsibilities. The professionals are in the best position to make informed guesses as to which project within a general program is most likely to yield results of practical benefit. The broad view of Board Members (including representatives of the Department) provides the necessary perspective in assessing the needs of industry, government and

2.7.(a) (ii) (2) cont'd.

science in general. It is through the chain from the laboratory to the Regional Advisory Committee to the Board that the research requirements can be brought together to establish priorities in light of the welfare of the nation as a whole. Here again, because of markedly different conditions prevailing in fisheries from region to region there are grave difficulties, taxing the judgment of the Board to the utmost, in ranking programs in order of their potential economic contribution to the national productivity.

(3) At all stages in the deliberations on priorities (laboratory level, Regional Advisory Committee, etc.) there is continuous input by the Office of the Chairman. At the same time this office is in close touch with Treasury Board officials to determine general guidelines on expenditures, to conduct an annual program review in light of long-term objectives, and to seek approval in principle for special projects. The parallel processes of consultation between the Office of the Chairman and the Board and between the Office of the Chairman and Treasury Board clear the way for the Executive Committee to determine precise allocations of funds. These of course are still subject to change until approved by Parliament.

(iii) Network methods to plan and monitor programs

The Fisheries Research Board to date has not used any of the network methods in the planning and monitoring of programs.

(iv) Contracts in support of intramural programs

In areas of Board responsibility, the policy has been to contract for jobs which can be done better by outside agencies or individuals. Between 1962 and 1967,

2.7.(a) (iv) cont'd.

37 contracts were signed, mainly with universities (27) but also with individual specialists (8) and other research agencies (2). Enumerating these has had to be somewhat arbitrary in view of the fact that within this period the Board began introducing its program of university grants (see Section 2.3.(a)) and prior to 1965-66 grants were not always clearly separable from contracts. The allocations and purposes are provided in Appendix XXVII, and summary total expenditures are as follows:

1962-63	$22,900
1963-64	$15,300
1964-65	$43,900
1965-66	$13,000
1966-67	$47,000
1967-68	$89,000
1968-69	($89,000 - forecast)

(v) Funding of extramural research programs

The policy of the Fisheries Research Board concerning university research programs has been generally outlined in Section 2.3.(a) and is more specifically covered in Appendix II. Broadly, the objective is to provide a system of university support of a distinctive nature, which will not duplicate other federal programs, and which will complement and assist the Board's research by establishing a suitable environment for University/ Fisheries Research Board cooperation.

(vi) Shifts in emphasis

Shifts in resources from one FRB research program to another are of common occurrence and always under consideration. A case history to illustrate the method may be drawn from the Board's program review for 1969-70. In light of Treasury Board's directive to restrict expenditures to the same level as in 1968-69, there was no other course but

2.7.(a) (vi) cont'd.

to reduce or eliminate certain programs in order to provide resources for urgently needed investigations. For example, personnel and funds are being shifted from groundfish research in the Atlantic to support expanded programs on Atlantic salmon and herring. High seas tagging of Pacific salmon has been at least temporarily abandoned in favour of investigations aimed at expanding the resource base of Pacific salmon (such as enhancement of the resource by artificial propagation). Other reductions, such as in Arctic fisheries work and in physical oceanographic studies off the Atlantic coast are being effected to permit increased biological research on North Atlantic whales in view of impending international negotiations, and to allow for increased biological oceanography in the Atlantic.

(vii) Communication of results

The most usual procedure for communication or transferring of intramural and contracted extramural results to potential users is by means of several kinds of publications. These are described in Section 2.8. below. However, results are also communicated orally through formal or informal meetings. For example, on the Pacific coast there is a Herring Management Committee consisting of representatives of FRB and the Department which meets at irregular intervals with delegates from the fishing industry to discuss new biological information and its bearing on existing or proposed management procedures. A similar committee meets annually to consider scientific evidence in light of the requirements for management of the Skeena River salmon fisheries. From time to time there are informal meetings with industry representatives to discuss the prospects for expansion

2.7.(a) (vii) cont'd.

or development of new fisheries, or to provide forecasts of fishing success where fisheries for some species are affected by large annual variations in abundance. At some technological stations liaison officers make visits to fish plants to acquaint processors directly with new techniques and discoveries.

(b) UNITS EXCLUSIVELY CONCERNED WITH EXTRAMURAL RESEARCH ACTIVITIES

There are no Board activities exclusively concerned with extramural research activities.

2.8. RESEARCH OUTPUT

(a) PATENTS ARISING FROM RESEARCH ACTIVITIES

The FRB is not in the business of inventing things which can be patented. Occasionally, and sometimes quite by accident, there is a development which in the eyes of the Board might fall into the hands of a manufacturer bent on profiting by the invention at the expense of the Canadian fishing industry. Appendix XXVIII lists the few patents which have been acquired since 1962. None has produced appreciable income for the government.

(b) BOOKS AND JOURNALS ARISING FROM RESEARCH ACTIVITIES

(i) The Office of the Editor of the Fisheries Research Board, with its headquarters in Ottawa, is responsible for production of the Journal of the FRB. This publication with its predecessors has been continuous since 1901.

(ii) The FRB Journal contains scientific articles concerning aquatic organisms, environments, technological accomplishments which are relevant to Canada and its fisheries. So popular has the Journal become as an outlet for scientific discovery, it is now published

2.8.(b) (ii) cont'd.

once a month, instead of quarterly as was the case a few years ago. As an example of the growth, 205 articles were published in 1967 as opposed to only 80 in 1962. There has been a steady increase in the number of authors from fisheries agencies, or universities outside the Board. (See details, Appendix XXIX).

(iii) Another important series of publications is the Bulletin of the Fisheries Research Board, which is published at irregular intervals, but nevertheless has increased from 5 issues in 1962 to 11 issues in 1967. The Bulletins in contrast to the Journal articles are intended to be comprehensive in coverage of fairly large topics. Some of these are purposely written in a non-technical style to meet the needs of people in industry, lower level educational institutions, etc. (See Appendix XXIX). Board scientists also publish papers in non-Board publications, many of which have high international reputation. Since 1962 the numbers of such publications have varied from 57 to 125 per year. These outside publications are each year reproduced and bound in a Study Series.

(iv) Starting in 1967 the Office of the Editor established a separate series for articles which contain little contribution to new knowledge but are designed to synthesize and interpret the accumulated results of past FRB research. In that year the numbers of interpretive articles amounted to 75.

(v) The Board also publishes an Annual Report and a biennial Review of investigations. These are written to meet the needs of parliamentarians, and others who wish to keep broadly informed on the progress of FRB research.

2.8. cont'd.

(c) OTHER KINDS OF REPORTS ISSUED BY THE BOARD AND ITS LABORATORIES

(i) During the 1962-67 period, 135 Circulars were issued to industry. These cover a wide range of subjects from results of exploratory fishing, results of tagging studies (in which fishermen show much interest), forecasts of fishing success, reports on herring spawning, etc.

(ii) To keep pace with the rate of collecting and rough processing of data, it has been found helpful to record great varieties of information in a Manuscript Report Series. These documents (multilithed) have restricted distribution to libraries of other Board Stations and to Board Members. Occasionally, copies are released for use of interested persons outside the Board. For various reasons these are not suitable for formal publication, but eventually the information consolidated from them appears in publication. Between 1962 and 1967, 355 Manuscript Reports were prepared.

(iii) In 1967 a new series Technical Report Series was initiated and 40 issues were put out that year. These multilithed reports have wider circulation than the Manuscript Reports because of the desirability of keeping scientists elsewhere abreast of current developments. Like the Manuscript Reports, however, they are still regarded as sub-publications. Both kinds of reports serve a useful purpose not only for the quick dissemination of scientific results but also are useful as a reference in formal publications (thus cutting down substantially the amount of basic tabular data which is so costly to reproduce in formal publications).

2.8. cont'd.

(d) CONFERENCES AND OTHER VEHICLES FOR REPORTING RESEARCH OUTPUT

In connection with the Department's and Board's involvement in international fisheries conventions, there is occasion to convey results of scientific investigation to extra-mural groups (scientists of other countries). In addition, there are frequent conferences with industry, through special committees established jointly by the Board and Department. Lectures are arranged annually, in some instances through university extension departments, to enable direct presentation of results to fishermen and industry people. From time to time in cooperation with universities special symposia are arranged with invited participation from widely scattered extra-mural groups. Finally, most of the Board's laboratories hold an "open-house" once every 2 or 3 years. Some of these attract large numbers of visitors not only from the industry but the general public.

(e) TRANSFER OF FOREIGN SCIENTIFIC DATA TO EXTRA-MURAL GROUPS

The only area in which this particular kind of communication might apply is in the Board's Translation Series. To the end of 1967 it contained 960 English translations of scientific articles. Most of the requests for translations originate with FRB scientists and the work is usually carried out by federal government translators. The list of translations is widely distributed annually and through this, scientific personnel of extra-mural groups (inside and outside Canada) may make use of the translated material.

(f) FRB EMPLOYEES WHO HAVE MADE IMPORTANT CONTRIBUTIONS ELSEWHERE

A total of 48 FRB employees had opportunity to train themselves in specialized fields while employed with FRB and subsequently left and made important contributions to their field elsewhere. This number includes individuals who, subsequent to their contribution elsewhere, returned to FRB (Appendix XXX).

2.8. cont'd.

(g) RESEARCH TEAMS

Research teams which emerged during the 1962-67 period with unique and valued abilities in important fields are of two kinds -- those arising from decisions to focus intra-mural attention on a particularly important problem and those of an extramural nature stimulated by FRB contract support (e.g. to universities). At least 12 team-research projects are in existence at FRB laboratories, with two others at the University of Toronto and University of British Columbia. (Details of these projects are given in Appendix XXXI).

(h) UNIQUE OR VALUABLE RESEARCH TOOLS, FACILITIES OR PROCESSES ADDED OR DEVELOPED SINCE 1962

(i) Laboratories

The Marine Ecology Laboratory was established at the Bedford Institute in Dartmouth with the inclusion of a water laboratory. Laboratory expansions were made at the Halifax Station and at the Freshwater Institute in Winnipeg. A large addition to the Nanaimo Station is under construction, while water-front property in West Vancouver has been acquired in anticipation of needs for further laboratory facilities on the west coast.

(ii) Vessels

In the years since 1962, the Board had two moderately large research vessels constructed -- the 170 ft. G.B. REED operating out of Nanaimo, B.C. and the 130 ft. E.E. PRINCE out of St. Andrews, N.B. In addition, several smaller vessels were commissioned, the largest of which was the 54 ft. CALIGUS for early sea life studies of Pacific salmon. The Vancouver Station constructed an experimental barge for testing construction materials for fishing boats and handling of fish.

2.8.(h) cont'd.

(iii) Equipment

Among major items of equipment acquired since 1962 are the mass spectrometers located at the Halifax and Vancouver Stations; experimental refrigeration equipment at Winnipeg and St. John's; fish thawing equipment at St. John's. At Nanaimo unique equipment in the form of respirometers were designed and constructed for the purpose of conducting studies of metabolic processes of salmon.

(i) IMPACT OF SCIENTIFIC ACTIVITIES AND RESEARCH OUTPUT

As indicated above, 2.8.(b), the Journal and Bulletin series of the FRB are the main vehicles for dissemination of scientific information. The former has a long and honourable history and is today the largest journal of biological sciences in Canada and one of the world's leading publications in aquatic science. Its growing subscription list and the growing number of outside contributors attest to its world recognition and impact in the advancement of scientific knowledge. The impact which FRB scientific research activity and output has on the economic development of Canada is not easy to measure but nevertheless it is considerable. Among dozens of positive achievements (a few of which are listed under Section 2.10. below) the Board has more than justified its existence in many sectors of the economy. Technological innovations such as refrigerated seawater, discovery of new fishing resources and development through chemistry of new products are tangible examples. Less tangible, however, are the benefits derived from increased knowledge of the biology of various species. For example, let us examine the valuable salmon resources of the Pacific. There is no doubt that increased knowledge provided by FRB activities has been of valuable assistance to the Department's management program. Furthermore, one might well ask what would be the status of the salmon resource today, had scientific knowledge been insufficient in the eyes of the International North Pacific

2.8.(i) cont'd.

Fisheries Commission to prevent exploitation of Canadian salmon by foreign nations. There is no doubt that the dissemination of scientific information directly to fishermen adds significantly to their efficiency otherwise dependent only on experience, intuition and plain luck. An outstanding example of this was the Board's efforts towards the end of World War II to draw to the attention of fishermen the superb advantages of the echo-sounder in locating schools of herring and other pelagic fishes.

(j) OTHER INDICATIONS OF RESEARCH OUTPUT

In 1964, FRB commissioned the National Film Board to prepare a film on the high seas research conducted by the Nanaimo Biological Station particularly in respect to the studies on the high seas distribution and migrations of Pacific salmon. This film has been given wide circulation for the benefit of educational institutions and the general public. In addition special copies were presented to fishermen's organizations and fishing industry associations.

2.9. PROJECTS

(a) SUMMARY OF PROJECTS UNDERTAKEN BY UNITS

In the following presentation, projects within programs are treated in broad terms and with reference to the whole period 1962-67 rather than by individual years. While most of the programs are of long-term duration, many small projects have been completed in the 6 year period (about 1700) and no attempt has been made to list them here.

(i) St. John's Biological Station and Technological Unit (Newfoundland)

The major programs of the Biological Station are of a long-term continuing nature having their origin prior to 1962. They are concerned principally with species which are of present or potential commercial importance in the fisheries of the

2.9.(a) (i) cont'd.

northwest Atlantic with special emphasis on the fisheries of Newfoundland. Many of the research results are used to fulfill Canada's commitments to the International Commission for the Northwest Atlantic Fisheries.

(1) The Groundfish program is the most important and has within it research projects on the population biology of cod, haddock, redfish, American plaice and several other species of flounders.

(2) The Atlantic Salmon program was concerned primarily with biological studies in the freshwater environment. Recently a research project on the high seas distribution of salmon was introduced in view of the concern about catches of Canadian salmon by foreign nationals off Greenland. There is also a project involving the transplantation of Pacific Pink Salmon to Newfoundland rivers. This project had its beginning in 1964.

(3) Another program of a continuing nature consists of studies on Commercial Invertebrates within which are projects on lobsters, oysters, squid and marine algae.

(4) Beginning in 1966 an extensive program on Herring was initiated to provide biological background for development and management of the now burgeoning purse-seine fishery for that species. Another project concerns the Capelin (a member of the smelt family) which is of minor industrial importance at the moment but possesses great potential.

(5) In support of the marine studies a Hydrographic project provides monthly or seasonal observations of

2.9.(a) (i) (5) cont'd.

temperature and salinity structure overlying the Grand Banks and other important fishing grounds.

(6) The Technological Unit investigates methods of handling and storage of fish. This unit has engineered new ways of freezing and thawing fish, and improved systems that produce commercial products with better chemical, taste, flavour and sanitary characteristics.

(ii) Marine Ecology Laboratory (Dartmouth, N.S.)
This laboratory, originally a branch of St. Andrews, was given independent status in 1965 and a new, expanded study of the processes underlying marine production was begun. Emphasis in the research is being placed on increasing knowledge of the structure and dynamics of the environment and biological resources, and the effects of these characteristics on harvesting of the resources. The main projects concern:

(1) Environmental studies of marine circulation; physical, chemical and biological properties of sea-water and bottom sediments, and changes brought about by human interference.

(2) Resource evaluation particularly of bottom dwelling animal communities. A sub-unit at Malpeque, P.E.I. specializes in oyster research.

(3) To aid in the harvesting of resources studies are being made of the schooling behaviour of fishes, and electronic sonic equipment is being developed to count fish.

2.9.(a) cont'd.

(iii) Halifax (Technological) Laboratory (N.S.)

The program in Atlantic technology (physiology, biochemistry and nutritive value of marine and freshwater organisms, and how they may best be utilized through preserving, processing, storage and distribution) is carried out at the Halifax laboratory and its technological sub-unit at St. John's and station at Grande-Rivière. Some projects are carried out in commercial plants. The program is centrally coordinated and concerns mainly:

(1) Improving or preserving quality of fresh and frozen fish and shellfish through studies on rancidity, flavour changes, techniques of freezing and the use of radiation and chemical preservatives.

(2) Manipulation of the resource by detection and prevention of diseases of fish and shellfish; controlling mortality and infection in lobsters; diagnosis of diseases in hatcheries; investigation of reproductive and other hormones of fish and shellfish.

(3) Freeze-drying of fish products, and cost analysis of fish protein concentrate.

(4) Biochemistry of fish and shellfish including chemical analysis of marine oils and seaweeds.

(iv) St. Andrews Biological Station (N.B.)

Research at this station is generally aimed at providing information applicable to sound management and full utilization of marine and freshwater resources available to Maritime fisheries. Here again, most of the programs are necessarily of a long-term nature and have been in existence throughout the 1962-67 period. The main programs and the projects associated with them are as follows:

2.9.(a) (iv) cont'd.

(1) Environmental studies including effects of pollution by mining and pulp mill effluent and effects of sedimentation on bottom organisms.

(2) Investigations of the resource involving exploration for new fish stocks and new fishing areas; population studies on these stocks as well as on stocks of fish, lobsters and scallops being subjected to exploitation. Assessment of resources of groundfish, surface fish (herring, mackerel, swordfish, etc.), and Atlantic salmon with special emphasis on early life history in freshwater, including effects of pesticides on survival.

(3) Study of methods for increasing the resource of such valuable species as lobsters and salmon.

(4) Harvesting efficiency in such areas as the study of fish behaviour, effects of restricted and unrestricted fishing and improvements in the efficiency of fishing.

(5) Studies of utilization in respect to optimum procedures for harvesting and holding species after capture.

(v) Grande-Rivière (Technological) Station (P.Q.)
At this laboratory, which is under the administrative supervision of the Halifax Laboratory, research is being directed to non-bacterial factors that contribute to rapid deterioration of fish and shellfish. Protective coatings for frozen fish products have been developed and new drying methods for processing cod steaks are being explored.

(vi) Arctic Biological Laboratory (Ste. Anne de Bellevue, P.Q.)
This station is responsible for marine, freshwater and

2.9.(a) (vi) cont'd.

anadromous fish studies in the Canadian Arctic and subarctic, and for aquatic mammal research in our three oceans. Associated studies deal with the factors limiting production of aquatic fauna. The major programs are as follows:

(1) Environmental studies such as the bearing of chemical constituents on plankton production in Great Bear Lake, and the process of mixing of Arctic marine waters with those of the Atlantic and Pacific.

(2) A program of exploration to identify and define the distribution of marine and anadromous fishes.

(3) Fish population studies on the abundance of species in marine bays, rivers and lakes of the Arctic area.

(4) A Harp Seal program has been in existence for 17 years for the purpose of developing a sound biological background for management of the now controversial sealing industry of the Gulf of St. Lawrence and northwestern Atlantic.

(5) Population studies on other mammals involve determination of the abundance of grey seals, fur seals, sea-lions and white whales with the view to establishing a basis for rational exploitation or measures for control. Data on fur seals form part of Canada's commitment to the International North Pacific Fur Seal Commission. Information, likewise required for management purposes and use by the International Whaling Commission, is collected on the large whales of the North Atlantic and North Pacific.

2.9.(a) cont'd.

(vii) Freshwater Institute (Winnipeg, Man.)

The Freshwater Institute was established on the campus of the University of Manitoba in 1966. The Institute includes the staffs of the former London Biological Station and Technological Unit. It has major responsibility for Board research related to Canada's inland lakes and rivers and their fishery resources. There are three program divisions:

(1) Eutrophication. A multi-discipline fundamental research on mechanisms and processes of biological production and decomposition in lakes with emphasis on the effects of nutrient enrichment. The developing research of this section is part of a coordinated Canadian program dealing with the problem of pollution on the Great Lakes.

(2) Fisheries Technology. Provision of scientific and technical information for development of the most effective utilization of freshwater fishery products. The program involves fundamental and applied biochemical, chemical, microbiological and engineering studies.

(3) Fish Population Dynamics. Studies of the life history, population dynamics and ecology of freshwater fishes and the fish production capacity of lakes.

(viii) Vancouver (Technological) Laboratory (B.C.)

The laboratory, located on the campus of the University of British Columbia, emphasizes:

(1) Partial freezing of groundfish in salt-fortified refrigerated sea water to improve quality; conditions responsible for postmortem development of "chalky" halibut; studies on the organism causing botulism in fish products; quality control in canned salmon;

2.9.(a) (viii) (1) cont'd.

desiccation of frozen fish; reactions of muscle proteins with products of fat oxidation; preservation of herring for reduction and anti-oxidant treatment of herring meal intended for bulk storage.

(2) Biochemical studies on live salmon includes studies of maturation and migration of smolts; effect on their tissues of feeding maturing sockeye salmon as part of a general study of post-spawning survival; mode of action and purification of certain protein hormones related to spawning migration.

(3) Biochemical classification of fish by means of muscle or haemoglobin protein patterns; chemical systems responsible for postmortem control of carbohydrate metabolism in fish organs, and breakdown of muscle fats (rancidity); chemistry of fish flavours.

(ix) Nanaimo Biological Station (B.C.)

The Nanaimo Station is the largest of the Board's laboratories, being involved in various aspects of research on salmon, herring, groundfish, crabs, shrimps, other invertebrates; environmental research on natural oceanic phenomena as well as the growing problems of marine and freshwater pollution. Most programs originated prior to 1962 are designed to provide a sound basis for management or such other action as may be required of the Department of Fisheries. The main program divisions are:

(1) Salmon investigations which involve identification of stocks and forecasting of abundance of salmon in approaches to major river systems like the Skeena; cooperation with the Department in assessment of escapements, and effectiveness of natural and artificial spawning channels; study of the hardiness of salmon fry

2.9.(a) (ix) (1) cont'd.

in hatcheries and nature, with evaluation of effectiveness of hatcheries for chinook salmon; study of bacterial infection of salmon eggs, kidney and other diseases; research on the physiology, behaviour and genetics, and the parasites of salmon.

(2) Marine fishery investigations to determine the causes of and reliable basis for forecasting abundance of herring; effects of domestic and foreign fisheries on abundance of groundfish with studies of neglected but potentially valuable species; population studies on shrimps and crabs, and establishment of self-supporting populations of Atlantic lobsters in British Columbia waters; and studies to determine the biological basis for expansion of the oyster industry and more efficient utilization of clams and abalone.

(3) Oceanographic programs involving studies of primary and secondary (zooplankton) production in the open ocean and in the Strait of Georgia; relationship of surface water variations to fluctuations in abundance or availability of fish; plankton production and its relation to feeding habits of fish; and effects of tides and Fraser River discharge on circulation within the Strait of Georgia.

(4) Pollution studies involving the monitoring and assessment of the extent of pollution by pulp mills, domestic sewage systems and waste from other industrial enterprises.

2.9. cont'd.

(b) SIGNIFICANT COMPLETED PROJECTS

For present purposes an attempt has been made to classify projects in the terms requested -- namely "basic research", "applied research" and "development". In actual practice, however, FRB, being mission-oriented, conducts little "basic research" (i.e. a generalized search for knowledge without specific application in view). Emphasis has been placed on those achievements which had a fairly direct bearing on the fisheries. However, as members of the scientific community at large, FRB scientists have in many cases achieved international status as leaders in their chosen fields of science.

(i) Achievements in "basic" research

(1) Contribution to general scientific knowledge. The Journal of the FRB is today the largest journal of biological sciences in Canada and one of the world's leading publications in aquatic sciences.

(2) Physiology of salmon. Detailed understanding of energy expenditures of migratory adult salmon, rates of sexual development and other phenomena have provided the basis for determining the biological consequences of installation of power dams, flood control dams and other obstacles.

(3) Salmon chemosensory studies. Demonstration of repellents from predators (including man) and partial characterization of homestream water materials.

(4) Important text books. A number of FRB personnel have received tribute for text books which are now in common use in educational institutions and in fisheries laboratories around the world. Recent books cover such topics as the fishes of the Atlantic coast of Canada, methodology in the study of primary production in the sea and methodology of assessing the dynamics of exploited fish populations.

2.9.(b) (i) cont'd.

(5) Species and population identification. Physical characteristics supplemented by critical examination of enzymes and isoenzymes to distinguish fish populations. FRB has become a world leader in use of electrophoretic techniques of identifying species and populations from muscle and blood protein characteristics.

(ii) Achievements in "applied" research

(1) Assistance to government. With Canada being member of no less than 9 international commissions, there is heavy demand for scientific knowledge to formulate Canada's position in critical international negotiations. FRB has performed a very valuable role in supplying information and advice required for drafting of conservation measures. For example, definition of the high seas distribution of Canadian Pacific salmon has put the government in a position where it can be alert to consequences of any alteration in the existing treaty with Japan and the United States or interloping nationals of other countries. Another example is the joint United States-Canada research which solved the problem of controlling sea lampreys in the Great Lakes.

(2) Refrigerated seawater. FRB scientists recommended application to transport and holding of fish, resulting in substantial economies for salmon industry. Potential recognized by other segments of the fishing industry.

(3) Plant engineering services. Assisted industry in layout of production lines, cold storage areas, etc. A fillet machine has been developed for production of fillets of uniform thickness. Also unloading pumps have been developed through close cooperation of FRB scientists and industry to provide for rapid, non-damaging unloading of larger fish such as salmon from vessel holds.

2.9.(b) (ii) cont'd.

(4) Fish protein concentrate. Fundamental FRB work on methods of extracting lipids from cod muscle led to development of a process producing FPC superior in quality to that produced by parallel research in other countries. Process adopted by scientists in the U.S.A. and commercial production in Canada is imminent.

(5) Product quality. In addition to 2 (above), other exclusive FRB accomplishments in improvement of fish quality include preservation of chilled fish with antibiotics, demonstration of the merit of aluminum pen boards for use in storing of fish in vessel holds, demonstration of brine-spray freezing and insulation techniques which have been adopted by industry in a number of tuna vessels. Also FRB pioneers use of ultrasonics to determine fish quality in certain species.

(iii) Achievements in development

(1) Scientific exploration. In several areas results of FRB discoveries of previously unexploited resources has led to significant increases in production: Atlantic and Pacific shrimps; Atlantic redfish, haddock and deep water cod; Arctic char and other northern fishes; American plaice and other species.

(2) Forecasting. Far reaching benefits to industry are provided by forecasts of fishery opportunities, as well as hazards. Examples: Techniques have been developed to forecast inshore abundance of squid in Newfoundland; results of long-term research have been successfully applied to management of Skeena River salmon stocks; forecasts of timing of oyster spat-fall enable oyster growers on the Pacific coast to maximize their spat collections; and identification of organism responsible for paralytic shellfish poisoning has enabled predictions of occurrence on the Atlantic coast.

2.10. EFFECTS OF SCIENTIFIC ADVANCES ON CURRENT OPERATIONS

(a) FORECAST OF EFFECTS OF CHANGES IN TECHNOLOGY

(i) The Board's own advances in the improvement of holding (freezing) facilities aboard vessels have opened the door to Canadian participation in fisheries for tuna and other tropical fishes. At the present time relatively few vessels are involved, but perhaps over the next decade further developments will improve Canada's competitive position in the tuna fisheries, thus diversifying her production and reducing dependence on heavily fished resources close to home. The economics of such ventures have yet to be properly tested, but should the fisheries expand to distant waters, scientific (biological) support would likely be sought by government and industry.

(ii) Technological developments during the past two decades, specifically the enormous growth of well equipped mothership factory operations by foreign nations, have placed great strain on the fisheries resources of the Atlantic and Pacific coasts of Canada. Although Canadian vessels are being modernized for increased efficiency, they are, for the time being, in a poor position to compete with nations operating from a lower economic base. It is expected however that, as the abundance of resources dwindle, the economic advantage will swing in favour of such nations as Canada which are close to major areas of production and able to operate at lower cost from shore bases rather than from factory ships. Thus, over the long term it is likely that reduced participation by other nations will permit Canada to assume greater control of the fisheries resources off her coasts and in the process make more effective use of fisheries science in the management of these resources.

2.10.(a) (ii) cont'd.

This presupposes that current international difficulties in reaching agreement on the utilization and sharing of resources will continue to hinder rational, scientifically-based exploitation.

(iii) Canada's current disadvantage in relation to foreign fishing fleets stems in part from the economic problem of exploiting high volume species of low unit value. In some quarters it is believed that the recent technological break-through in production of fish protein concentrate (FPC) will open the door to greater economic return from certain species now fished (e.g. herring) and at the same time bring into production species which currently have little or no market value (capelin, sand launce, grenadiers, dogfish, etc.). Such a development would most certainly create additional demands for the scientific information needed for rational utilization. However, there are nutritionists who maintain that FPC may never be able to compete effectively with other sources of supply as a protein supplement on the domestic market and that the prospect of strong market demand from the under-nourished peoples of the world requires examination of the total nutritional requirements. It is argued that where protein deficiency occurs, it is usually accompanied by caloric deficiency, and correction for the former alone, by extensive use of FPC, will not relieve malnutrition except in the case of very young children. If the caloric requirements are met by consumption of grains and other carbohydrates, there would be no need for additional protein. In any event, if forecasts of population growth are reliable, it can be anticipated that the demands for fish and other marine products will call for still further expenditures in fisheries science. Technological

2.10.(a) (iii) cont'd.

discoveries which would enable economical utilization of animals such as zooplankton will reveal the inadequacies of biological investigations which heretofore of necessity have been concentrated at higher levels in the pyramid of animal numbers.

(b) POSSIBLE IMPROVEMENTS IN EFFECTIVENESS OF RESEARCH DUE TO NEW SCIENTIFIC OR TECHNICAL DEVELOPMENTS

Within the past decade the world has witnessed an enormous development of electronic computers which have opened the way not only to analytical techniques previously considered too lengthy or complex to be done by hand, but also to automated instrumentation which was beyond the wildest of dreams. Fisheries research is only now beginning to take advantage of these discoveries. By-products of aerospace science are likely to have a profound effect on instrumentation for fisheries science. In particular, the developments of principles for the remote control of instruments will have a large impact on oceanographic support of fisheries research. Currently, synoptic monitoring of physical events in the sea, which control the distribution and abundance of important fishes, involves costly expenditures on ships and manpower. Even then the results are far from adequate. Prototypes of remote-controlled, anchored buoys equipped with highly complex sensing apparatus are now being tested and are likely to find widespread practical application in the next decade. These instruments can be programmed to make continuous observations of many oceanographic phenomena, and instructed to report their findings to fisheries laboratories via satellite or direct radio communication. Under the title of hydrospace research (as a counterpart of aerospace research), rapid advances are being made in the development and use of manned submersibles and sea-bed laboratories. All of these developments will have impact on fisheries science enabling more direct observation and understanding of the biological and hydrographic processes which affect man's efforts to make full use of the living resource of the sea.

2.10. cont'd.

(c) THE TYPE AND SOURCE OF REQUESTS FOR SCIENTIFIC OR TECHNICAL ADVICE

It is fitting under this topic to concentrate attention on the Board's concern about the ever-mounting problem of aquatic pollution. Until the present, efforts to assess its effects on fisheries and recreational opportunities and to develop satisfactory control measures have been badly fragmented. Jurisdictional disputes have been but one of the obstacles. The Board has long been involved in studies of pollution and its effect on fisheries, yet chronic shortages of funds and facilities coupled with lack of coordination with other agencies have resulted in only modest advances. Still, the Board has been able to offer at least some guidance to the Department of Fisheries, other agencies and industry. The recent establishment of the Interim Interdepartmental Committee on Water Programs, with its several subcommittees, is recognized as a valuable first step towards coordinating the work of federal agencies. In this potentially improved atmosphere, the Board is willing to offer its special expertise, recognizing that clean water for fish means clean water for man. Coordination and expansion of federal and provincial efforts to control or eradicate pollution of our valuable water resources is a most vital necessity.

(d) FUTURE PLANS DETERMINED BY RECENT DEVELOPMENTS

Plans have already been made to improve on conventional techniques of fish population enumeration by adoption of recent technical advances in echo-sounders and automated fish counters. A recent break-through in the technique of tagging small, juvenile fish promises new rewards in the understanding of migrations, homing tendencies and differentiation of populations. Greater use of television, video-tape recorders and manned submersibles will be made in the study of fish behaviour -- for the purpose of improving the efficiency of techniques of capture. New advances in the design and efficiency of mid-water trawling gear will be adopted to obtain better understanding of the economic potential of animals inhabiting the sound-scattering layers of the ocean. Most of the Board's stations include in their future plans more extensive use of electronic computers not only to free precious man-hours from menial computations, but also to explore mathematic models of populations, food-chains and other complex biological events for the purpose of understanding observed phenomena and the roles played by man and nature in limiting production from the aquatic environment.

APPENDIX I

Formal agreements with organizations outside of Canada regarding scientific activities.

1. INTERNATIONAL CONVENTION FOR THE EXPLORATION OF THE SEAS

A forum for international exchange of scientific information on fish, fisheries and the environment of the entire North Atlantic area, and concerned only indirectly with matters of fishery management. Canada became a formal signatory to this Convention in 1966. (Participation : Headquarters, East Coast regional laboratories of St. John's, St.Andrews, Dartmouth and occasionally the Arctic Biological Station and the Nanaimo Biological Station).

2. INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

An international scientific agency with the responsibility to collect scientific evidence for basis of management of fisheries in the northwest Atlantic area, upon which the fisheries economy of eastern Canada depends. Scientific information provided through the Canadian national section to the ICNAF secretariat and various committees. (Participation : East Coast regional Biological Stations of St. John's, Nfld., and St. Andrews, N.B., and the Marine Ecology Laboratory, Dartmouth, N.S.

3. INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

A three-nation agency (Canada, Japan and United States) concerned with the management of North Pacific fisheries and abstention by Japan from fishing stocks of salmon, halibut and herring of North American origin. Scientific information provided by Canada on high seas distributions of salmon, on oceanography, and evidence in support of the abstention principle. (Participation : West Coast, Nanaimo Biological Station).

4. INTERNATIONAL WHALING COMMISSION

A multi-nation treaty calling for scientific investigations and regulation of the Antarctic, Pacific and Atlantic whaling operations. (Participation : Arctic Biological Station).

5. INTERNATIONAL NORTH PACIFIC FUR SEAL COMMISSION

A four-nation commission (Canada, United States, Japan and USSR), charged with the responsibility for research and management of North Pacific fur seal herds. (Participation : Arctic Biological Station).

6. INTER-AMERICAN TROPICAL TUNA COMMISSION

A five-nation commission dealing with the tunas of the eastern tropical Pacific. (Participation : Scientific advice to Canadian Commissioner - on contract pro tem to personnel outside the Board).

7. INTERNATIONAL PACIFIC HALIBUT COMMISSION

A commission established by the United States and Canada to conduct biological research on halibut and to recommend to the governments such measures as are required for effective management. (Participation : Scientific advice from the Nanaimo Biological Station to the Canadian Commissioners).

8. CONFERENCE ON CO-ORDINATION OF FISHERIES REGULATIONS BETWEEN CANADA AND THE UNITED STATES

Established primarily for the purpose of achieving uniformity of fishery regulations where necessary along the Pacific Coast of North America. Of several committees only one remains active, the Trawl Fishery Committee which arranges for exchange of statistics and scientific joint research. The CCFR has not met as such since 1958, but there have been frequent meetings since that time to consider ad hoc problems.

9. COLUMBIA RIVER HATCHERY EVALUATION PROGRAM

Canada is co-operating with a United States committee for the purpose of evaluating the effectiveness of hatcheries in maintaining or increasing runs of chinook salmon to the Columbia River. Terms of reference have recently been expanded to include coho salmon and other river systems in the northwestern Pacific States. (Participation : West Coast, Nanaimo Station).

10. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED STATIONS

Canada is represented on a working committee of this organization, the Advisory Committee on Marine Resources. (Participation : Headquarters staff specialist).

11. THE GREAT LAKES FISHERIES COMMISSION

The Board supplies scientific information on the biology of lampreys to improve effectiveness of control programs and also advises on planning and organization of other research projects of mutual interest to Canada and the United States. (Participation : Freshwater Institute, Winnipeg).

12. INTERNATIONAL JOINT COMMISSION

Among problems of joint interest along the boundary of Canada and the United States is that of pollution. The Board is one of the four Canadian agencies providing scientific research on this subject. (Participation : Freshwater Institute, Winnipeg; Headquarters staff specialist).

APPENDIX II

Past, Present and Future Relations between the Fisheries Research Board and the Universities

1. IN THE BEGINNING

The FRB, founded in 1898, was previously known as the Biological Board of Canada. For the first quarter century of its existence, the researches of the Board were carried out exclusively by Canadian university professors, their students, and an occasional outsider. The universities had little or no money for research and no facilities of their own for aquatic field studies. Moreover, with the possible exception of McGill and Toronto, research was not a recognized part of the program of Faculties of Arts and Science; they were teaching institutions. Although the research topics at the Stations had to be approved by the Board there was little restraint, because the Board members were themselves the leading investigators at the Stations.

Operations were in summer and those accommodated were reimbursed for transportation from the university and provided with board and lodging only, in the residences at St. Andrews or Nanaimo. The work carried out by a student could be written up as a graduate thesis. Since there were no full-time scientists, there was no question of priorities for vessels or equipment. Board-University relations were close and cordial, although there were no formal agreements and no direct grants. Perhaps the main lesson from these early days was that in the field of environmental and resource science the provision of working opportunities is of prime importance.

The first full-time scientist of the Board was the Director at St. Andrews, who spent his winters at the University of Toronto, where he developed graduate work in marine science and supervised M.Sc. and Ph.D. theses, some of which were based on work in the Board's stations. This arrangement was unique in Canada and it terminated with the retirement of the incumbent.

After the first World War several developments combined ultimately to dissolve the partnership. One was the employment of a full-time

FRB scientific staff, who were year-round residents at the establishments. This introduced the idea of priorities and gradually, without planning, the claims of the university visitors to ship time and laboratory space receded. The second cause arose out of the policy of broadening the Board's work to include technology. The new men in biochemistry and bacteriology had as their university equivalents, members of faculties of medicine or agriculture who did not ordinarily spend their summers working at aquatic field problems. The idea of general food research, which might have formed a common link between the FRB and agricultural faculties, has never developed in Canada.

The culminating event arose from the great depression of the 1930's. During five successive years the Board's appropriations were, in thousands of dollars -

1930-31	$359
1931-32	$257
1932-33	$212
1933-34	$167
1934-35	$157

Under this stress the FRB discontinued the acceptance of university summer workers under the old arrangements. It has never been resumed, and could not be successfully restored in its original form at the present time. Consideration must rather be given to new approaches.

2. A GENERALIZED CASE HISTORY

With Memorial University the FRB has had a teaching arrangement for some years, with rights to offer instruction leading to the M.Sc. degree. At Dalhousie, over a period of 40 years, some half-dozen cooperative efforts have been set up. At McGill there was an FRB Arctic Station. The Toronto professor has already been mentioned. At UBC an on-campus laboratory was built and there was a similar teaching arrangement to Memorial, now fallen into innocuous desuetude. One may also recall experiences of the National Research Council on-campus establishments at Dalhousie and Saskatchewan. All these can be combined into a generalized case history which typically proceeds sooner or later, towards the decline and dissolution of the compact.

The proximity of a Board enterprise to a university campus marks the beginning. (No further relation may develop as with the Arctic Station near Macdonald College). Often however, the university has actively forwarded the project, perhaps by a gift of land etc., in the belief that academic strength will be gained. This is sometimes done by the administration without prior approval of the faculty. The faculty may then reject any effective collaboration, perhaps on the grounds that the point of view of an applied group is unsuitable for the academic world. Thus the earliest causes of the partnership death are still-birth and strangling in infancy.

Usually matters are more favourable and an active joint effort begins. The university is interested in extending the range of its scientific offerings and increasing its staff at the research level. Some Board people are looking for the stimulation provided by graduate students with a bias towards aquatic science, and to the enlargement of scholarly contacts, and others offer lip-service. There is every appearance of a viable bargain from which both parties might derive continuing benefit.

The serpent can enter this Eden in various guises. A penurious president may block the normal university staff development because of the strength provided by the outsiders. The government lab may bid for the best of a scarcity of graduate students. Faculty members may, with increased strength feel there is no longer need for the mundane partner or that departmental control, prestige and prerogatives are being compromised by developments outside its control. The Board people have usually been paid more and often seem to give low priority to formal teaching obligations while the full-time faculty are bowed down during term time with elementary teaching. As government complacency is matched by faculty irritation the resentments grow.

Typically at this stage one of the principals who shook hands at the outset, leaves. His successor, if on the government side, may feel that his people are wasting their time with teaching, or even with academic contacts, which introduce more new ideas than there is time for him to deal

with. If the new man is on the university side he may resent the encroachment on his prerogatives and on the complete control of his departmental staff. In either case the end is in sight; the formal arrangements fall into disuse. There may remain some personal and informal relations. The university may formally terminate FRB as well as other outside arrangements and in effect withdraw from resource-based science.

3. THE PRESENT

There are not at present any FRB rooms, ships or facilities especially labelled and reserved for university use. Few FRB lab facilities are unique; the Board's uniqueness is the presence of a large multi-discipline group of scientists in a particular area with a reasonable array of tools.

The current university ties of some FRB laboratories are as follows:

Nanaimo. Three graduate students from UBC and one from Victoria doing thesis work at lab. In 1965-66 a complete seminar course was organized and given at UBC. Annual assignment of vessels to UBC for 2 to 4 cruises of 2-3 days each. Staff serves on graduate student committees; exchange of research equipment.

Vancouver. Two UBC graduate students under partial thesis supervision. One joint project with a UBC staff member. Staff serves on graduate student committees; provision of special materials, e.g. hormones. Saskatchewan University professor spending a sabbatical year at the laboratory.

Winnipeg. FRB campus laboratory opened September 1966, built by University of Manitoba for rental to Board. Joint graduate programs under development in several phases of freshwater science. Recognition of relationship by University, which has produced a unique policy statement: "Cooperation between Government Organizations and the University of Manitoba."

Developments during the 1966-67 session have included: FRB Director is a member of the University Aquatic Biology Research Unit, a committee organized by the University to promote research and teaching in aquatic biology in three university departments, the FRB Institute and the Manitoba Fisheries Branch; seminar program jointly sponsored with Department of Zoology; three staff members recommended for appointment as Honorary Professors by the Department of Zoology; in new building being planned there are 10 laboratories designated for graduate students and three offices and laboratories for visiting scientists; cooperative research program on systematics of fishes underway between University professor and FRB scientist. Also two University of Alberta zoology students are doing their thesis research at Great Slave Lake with field accommodation, facilities and partial supervision provided by FRB.

Ste. Anne de Bellevue. Two McGill students under thesis supervision in lab; material for two other theses obtained through FRB summer employment and ship time in Arctic.

St. Andrews. About 18 recent and anticipated students have based theses on work at lab; several others have similarly worked at the oyster sub-station at Ellerslie. Eleven staff members are honorary Research Associates at UNB, and act on examining committees. Student groups from four universities have been given brief courses of instruction. Five staff members from three universities are doing joint research with lab staff.

Halifax. Two staff members have given series of lectures at Dalhousie University. Four graduate students did thesis work at lab. A McGill Ph.D. student spent final year at lab. One staff member is on the Dalhousie Faculty of Graduate Studies. Director has initiated enquiries leading towards a more clearly defined relationship.

Dartmouth. The founding of the Dalhousie Institute of Oceanography was dependent upon the establishment of the Bedford Institute of Oceanography, of which the FRB lab forms a part. FRB personnel have participated at Dalhousie in the teaching of physical and biological oceanography and marine geology, and have supervised graduate students from Dalhousie, St. Francis Xavier and McGill. Three FRB scientists currently hold Dalhousie appointments. Ship time provided to FRB by the Navy and time on FRB owned and chartered vessels has been shared with Dalhousie and McGill staff and students.

St. John's. The FRB Director holds an appointment as Professor at Memorial and has for 10 years (with assistance from colleagues) conducted one graduate course per year on a revolving 4-year cycle. This has led to a number of Master's degrees, currently 3 enrolled, usually FRB employees. Board staff also participate in academic colloquia and in the University extension service. A unique feature is the FRB undergraduate scholarships, set up some years ago; when established these were the best in the University and they have recruited some half-dozen Board employees.

4. CONDITIONS FOR A DURABLE ALLIANCE BETWEEN A UNIVERSITY AND THE FRB

In any ecumenical movement, whether religious, international or FRB-University, the greatest difficulty arises out of the character and ambitions of individuals. There are great differences in philosophies, attitudes and policies. The rate at which science and education are changing makes it imprudent to look more than a decade ahead, and even this projection is subject to continuance at the working level, of the people who began the arrangement, or replacements of like mind.

The greatest scientific obstacle is that the government approach to science tends to be interdisciplinary, built around environmental problems or objects such as fisheries, pollution, water etc. These do not interact naturally with the traditional university departments of chemistry, physics etc. Canadian universities differ enormously in their readiness to

experiment with interdisciplinary science and only a minority are likely at present to find administrative and faculty support for working out such ventures.

A practical problem arises out of the need to reconcile the government requirement for accountability of funds to Parliament with the professor's traditional freedom to choose how he spends his time. In the solicitation of major support for university research the issue of scientific freedom versus fiscal responsibility is a potential cause of irritation which can be partially alleviated by care in the drafting of proposals. But as a general trend it appears that academic freedom is inversely proportional to apparatus costs.

In any university there are some faculty members who fear that cooperative arrangements with a government agency, while beneficial in the short run, have a harmful long-range effect because:

- departments may lose their freedom to develop into areas which have been preempted by the external research agency.
- graduate students, attracted by the federal facilities, may drift away from the intra-mural departments.
- as a consequence of the foregoing the quality of the faculty may decline, and
- the administration may postpone development of laboratory space and apparatus because of temporary use of federal installations.

In a faculty where views like these are decisive, either by reason of the influence or number of their exponents, attempts to develop cooperation are unwarranted.

In the next section there is a statement of FRB policy towards joint enterprises with universities. This has been developed out of observation of our failures and occasional successes in the past.

Similarly some ideas have emerged about university administration and faculty attitudes which are likely to contribute to the avoidance of failure. While the FRB does not regard academic recognition of its participating scientists as an essential part of a cooperative plan, it does have some value as an indicator of the level of university enthusiasm.

It would be desirable then, to have from the universities:

- Acceptance of the idea that there is in Canada a growing competition for research personnel between government and universities, and that the government laboratories, which have a highly qualified staff, should contribute to the graduate university program. The same is true of expensive or unique apparatus and facilities.

- Development of the field intra-murally. The university should acquire independent strength. To use a government laboratory as a substitute for proper staffing is disastrous to faculty morale.

- Approximate equality in salaries and adequate free time available for research. There is hardly any topic where improved communication is needed more than the estimate of other people's research time. The non-research obligation of government scientists to advise their ministries, industry, international commissions, etc., is as mystifying to outsiders as is the stretch of up to five months when professors do not teach. It is not expected that government personnel will take up, during the session, a teaching load equal to that of the full time university staff.

- Formal provision for joint regular consultation about matters of common interest. Possible areas of friction and personality difficulties require continuous monitoring. The ideal of joint research between Board and university appointees can be encouraged.

- Understanding that the university should initiate academic proposals for direct Board support. These should be relevant to the Board's contemporary fields of interest, which will vary with the changing frontier of science. It is difficult for the FRB, under its Act, to accept applications of the formula type: "We have n professors, each of whom has x students requiring y dollars for equipment and z dollars as stipend. Multiplying this out . . ."

5. UNIVERSITY POLICY OF THE FISHERIES RESEARCH BOARD

By strengthening its association with universities the Board expects to gain:

- An increase in the supply of high quality graduate students oriented towards FRB activities and aware of the material and intellectual possibilities of employment by the Board.
- An increase within the universities of active research in fields of interest to the Board.
- Intellectual stimulus arising out of specialist consultation.
- Direct cooperation on research projects between Board and university staff or graduate students.

Location of Laboratories

The establishment by the Federal Government of relatively expensive research facilities in close juxtaposition to certain universities, and the extent to which other universities should be consulted, presents a sensitive and difficult problem for the Board. The primary obligation of the Board is that of providing physical facilities and personnel in the most suitable places to carry out its mandate as established by Parliament. Although there is much to be said for establishing laboratories in proximity to universities it cannot be regarded as an imperative.

According to the FRB Act, a majority of its Board members must be scientists who are, in practice, chosen from the universities. This brings the university point of view automatically into consideration when discussing new installations. In the Board's view the only argument for general prior consultation, for example through the AUCC, would be where a facility was likely to give one university a singular advantage and thus place other universities in a poor competitive position. With their strong individualities, it may be more difficult for two or three universities to cooperate, than for a government agency and a university. The probability of success is perhaps inversely proportional to some power of the number of participants.

General Accommodation and Cooperation

As policy the FRB welcomes visiting scientists and graduate students and offers them whatever accommodation, equipment and vessel time is available. In current practice there is considerable variability between establishments. For the future the Board is ready to explore with university colleagues, proposals leading towards a restoration of the historical position, when Board laboratories were, in effect, national assets of the scientific community.

Contracts

Contracts are initiated by directors of FRB establishments. Their purpose is to get work done in areas where the FRB does not have full-time staff or competence. Some of these contracts are made with universities or university personnel, and there may be academic value attached. These contracts are not, however, designed as part of a university support program and are mentioned here only because some other federal agencies have different arrangements under which contracts are considered to be university support.

Grants

The major portion of National Research Council support for university research is provided through the mechanism of operating grants to individual staff members and presumably will continue to be for the

future. The Council's judgment is of men rather than of areas of science or geographical location. In addition to this general support the Government has decided, from time to time, that certain areas of science are to be developed and applied, health for example, or fisheries or pollution. Such decisions call for provision of personnel, obtainable by development of appropriate areas within universities. New scientific directions require new responses from graduate schools, which must be encouraged by the appropriate federal agency.

The university support funds of the FRB are of the order of one per cent of the NRC grants. Such a small sum spread over the academic community as individual awards, would be lost. More will be achieved by identifying a limited number of proposals relevant to fisheries and offering adequate support to these. In resource science, assistance in kind (ship time etc.) is often more valuable than the cash part of a grant. Hence proximity to an FRB establishment and intent to make joint use of manpower and facilities may be a determining factor in awards.

It would be a national misfortune if every major university in Canada specialized in aquatic science, and a national fraud if all pretended to do so. As with the newer branches of emergent science, the study of water and its organisms is so costly, both of manpower and equipment, that it must develop in a few centers of excellence. The support and encouragement of these is a legitimate aim of the FRB.

Grant applications are judged by a Board committee of FRB with a majority of university scientists. Applications are not judged on the basis of whether they will directly forward the program of a particular FRB establishment.

Special relations with certain Universities

It is unlikely that, in an era of science planning, the country will feel able to duplicate many large centers for particular researches. The example of places like Chalk River will doubtless spread to other sciences. If the impact of all branches of emergent science is to become available to graduate students some cooperation with universities must be sought.

Again, by analogy with the newer sciences, it is unlikely that a large number of small, scattered installations can offer adequate research opportunities. This point of view, so obvious in physics and astronomy, is not always recognized in biology where a teaching field laboratory is occasionally confused with a research installation.

Where a university is in proximity to one of its establishments, the Board is interested in developing a special relationship the nature of which will depend upon local circumstances, and is likely to change with time. Where the Board is setting up unique equipment, for example a marine station with holding tanks for live animals, this will be built, if possible, sufficiently in excess of FRB needs to provide for university workers. The Board will act as housekeeper for the facility either alone (comparable to Naples or Plymouth) or, following an agreement, in symbiosis with a university (comparable to Friday Harbour).

Ship-time. The FRB endorses the proposals for allotment of ship time to selected universities, as adopted by the Canadian Committee on Oceanography, April 20, 1967, and circulated as attachment 10 of the minutes. Since research requirements vary from small craft to the largest ice-breakers, the FRB believes it would be inefficient to encourage ownership by each university of a one-ship fleet. The FRB will join other members of the CCO in attempting to provide a national pool of vessel-time to be divided among users on some fair and agreed basis of scientific need. The FRB will join other members of the CCO in making representations to the appropriate federal authorities concerning the needs of selected universities.

Teaching. No member of the FRB staff is under an obligation to teach. Those who elect to do so, by arrangement with a designated university, should lecture or conduct seminars or group discussions with graduate students. The normal maximum load is one-half course per year or one full course every second year by each FRB scientist involved. Lecturing will be taken into consideration in assessing scientists for pay action and promotion. Lectures and student supervision during regular working hours should be regarded as normal duty and no additional remuneration should be necessary.

With the concurrence of the laboratory director, facilities for research by university staff and graduate students will be made available, whether or not the student is a present or potential employee of the FRB. The director of the laboratory concerned has authority and responsibility for such negotiations.

FRB scientists may enter into joint or complete supervision of graduate student theses, under conditions mutually agreeable to the university and the director. Where graduate students are doing their theses on Board premises the university is authorized to pay them at the going university rate and claim reimbursement from the Board. University claims may be arranged with the Awards Officer, FRB, Ottawa. These students will fulfill any departmental requirements such as demonstrating, participation in seminars, etc.

The FRB does not favour long-term secondment of its staff to university departments specifically to meet teaching needs. Universities should be staffed to carry out their primary function and government should assist financially, where necessary, to help them achieve this competence. The FRB can probably make its best continuing contribution by providing graduate training in its unique areas of specialty, and by supervising graduate students in the atmosphere of its multi-disciplined laboratories.

O T T A W A,
August 31, 1967.

APPENDIX III

The Fisheries Research Board of Canada
and its place in the scientific development
of Canada during the next decade. 1968-1978.

I. INTRODUCTION

" The Board has charge of all Dominion fishery research stations in Canada, and has the conduct and control of investigations of practical and economic problems connected with marine and fresh water fisheries, flora and fauna, and such other work as may be assigned to it by the Minister." *

The Canadian Government has a responsibility to know all that can be known about the total Canadian environment. This includes the vast Canadian bodies of fresh and salt water. These waters are unique to Canada, and while knowledge gained elsewhere may be useful on occasion, it can never be a substitute for a detailed understanding of our own aquatic environments and the life therein. As noted above, the Government of Canada at one time delegated its primary responsibility in these matters to the Fisheries Research Board of Canada. From time to time new agencies have been created by the Government to deal with special problems. Where responsibilities overlap the FRB may participate in the new research or, to avoid duplication, its existing activities may be coordinated as required.

It is not enough to be charged with responsibilities; it is also necessary to discharge these responsibilities through the best available means. The deployment by the FRB of limited resources has in the past brought notable returns in specific areas where definite problems in aquatic resources demanded solutions. In large part these problems and successes resulted from the rapid change in the fisheries of Canada from fairly primitive harvesting operations to vertically

* From the Fisheries Research Board Act.

integrated food industries. A relatively few talented scientists have thus brought the FRB to a position commanding respect from its international peers.

We are now in the era of the "information explosion". It is widely recognized in science that this has resulted in the narrowing of personal interests to the point where scientists find it difficult to communicate with each other as well as with the public. The FRB is a unique interdisciplinary organization which unites experience and motivation in diverse sciences for the benefit of fisheries and water resources generally.

This approach is well illustrated by the fact that FRB scientists are aware of many alterations in populations of microscopic aquatic organisms which subtly reflect alterations in water quality. The cumulative expression of these alterations is readily recognized as "pollution", but at this late stage not only are valuable freshwater fisheries lost but the water itself may be lost as a social and economic resource. The few lonely complaints of a few years ago concerning loss and destruction of our freshwater resources have become a chorus of bitter recriminations. Action must be taken, but the economic implications of comprehensive pollution control are so staggering that any proceedings must have a sound scientific basis. The fusion of available talents in physics, chemistry and biology will enable FRB scientists to make substantial contributions, based on sound scientific principles, to a better understanding of water pollution and the effects of measures necessary for pollution control.

The FRB's present activities range over a wide area, both scientifically and geographically. Few fields of research are covered in sufficient depth to have as great an impact on the fishing industry or in the field of science as would be desirable. The FRB could double or triple its effort before it could be described as meeting its present research commitments. One area which illustrates the lack of knowledge concerns the gross and detailed physiology of most of the commercial

species found in our marine waters. Very little has been done in this field despite its importance to manipulation of the resource and to the finished product. Unless the effort is expanded considerably it may be decades before we know as much about commercial fish as we now know about rats, rabbits, guinea pigs and farm animals. Studies on nutritional and environmental requirements of even the most important species have had to be neglected, and metabolic studies where they are carried on are of limited scope. Only in very recent years have FRB scientists been able to devote a little attention to projects which have provided basic knowledge essential to the intelligent manipulation of the resource. The reasons for this are pertinent to future planning : (1) support tends to go first to projects related to present industrial practices, and these are based on a hunting economy; (2) field work, which costs about three times as much per scientist has, over the years, substantially exceeded laboratory work. Future plans will not neglect present industrial practices but will also allow for fundamental research to form a firm base for the industry of the future.

Canada should make a thorough study of its freshwater and marine environments even if it did not do any commercial fishing. In addition the FRB has an obligation to make itself an authority on the aquatic environment with the expectation that this knowledge and experience will allow a successful exploitation of all resources. It should be recognized that the oceans are <u>not</u> an inexhaustible source of economically recoverable food. International competition for marine resources grows more intense each year and more effort is required to catch a unit of fish in those waters close to our shores which have traditionally been fished by Canada. Improvements in present day harvesting techniques are not enough. We must also assist our existing industry to adapt to the exploitation of currently under-utilized stocks and species. Good management of resources such as salmon, lobsters, and certain less valuable species <u>under Canadian control</u> is absolutely necessary. Moreover there is a growing body of evidence and international recognition that fish farming and domestication of

fish could be expanded in the immediate future. No country has yet resolved all the problems of farming aquatic life forms, but Canada is in a good position to develop a scientifically-based industry.

Under our economic system fish and fishery products must compete on their own merits in food markets where there is intensive competition for the protein portion of the consumer market. The traditional fisheries cushions of religious, ethnic or economic practices are rapidly collapsing. As a food material, fish must not only be different, it must also be attractive in quality and price. Fisheries research is already making a substantial return to Canada's economy. In 1966 we were one of the three leading countries of the world in terms of value of fish exports.

It has been said that a vast area of the earth's surface, represented by the ocean bottom, is less well known than the surface of the moon. To this should be added the opaque layer of water, up to several miles thick, in which occur mysterious chain reactions subject to drastic modifications triggered by trifling alterations in temperature or chemistry. Fisheries research and aquatic science offer as much challenge, and can be as complex in its own right, as the current esoteric sciences of space research and nuclear physics.

Canadian fisheries and water resources have reached a point in relation to national economy, regional development, and population growth where solutions to problems can no longer be obtained easily with the present level of support. The Fisheries Research Board of Canada has incorporated the considered opinions of its working scientists into this presentation summarizing growth needs for the next ten years.

II GOVERNMENT RESEARCH IN FISHERIES: THE SOCIAL AND ECONOMIC BASIS

The view of the fishing industry regarding fisheries research, as expressed through the Fisheries Council of Canada in 1967, is that research should be expanded, and that this should be done by the Fisheries Research Board of Canada with the cooperation of the Department of Fisheries, of Provincial Governments, and through stimulation of fundamental research at universities.

Among the founding members of the Science Council of Canada nearly one-half the total are oriented towards engineering. This is an indication of the growing desire by government for technological applications. To an engineer progress is technology and usually means patentable mechanical processes in industries such as power, transportation, communications and manufacturing. These are intended to make the individual more effective in his environment. They are characterictically created directly from the most advanced science of our time. The supposed infinite and insatiable demand for these services and products is the basis for the idea of progress which the United States has given the world. Potential expansion is allegedly unlimited.

The industries of necessity, i.e. food, shelter and clothing, originated long before the application of science, and their practices changed only gradually through the centuries. It is said that in the Western world the mid 20th century marked approximately the crossover line from empirical to science-based technologies, which now make up more than half the whole. By the end of the century these industries of necessity will be almost completely science-based.

Fisheries, like other food industries, were built on pre-scientific experiences and skills passed on from father to son. The application of modern science requires the eventual phasing out of whatever existing methods prove uneconomic,as well as the introduction of new ones. Conservatism offers resistance to both processes, and

must be overcome by education and demonstration. The FRB provides the information needed to improve efficiency.

Because of the unequal distribution of world wealth, there exist pockets of plenty, as in Canada. In the struggle between East and West there is no doubt that we shall be increasingly supplying other countries with food, of which the most critical shortage is of edible animal protein. Canada has untapped reserves of aquatic animal protein to meet export demands, if this resource can be cropped and marketed at competitive world prices.

Why has fisheries research lagged behind agriculture in its practical accomplishments ? The main reason is the disparity in effort applied to the two fields. Most of the provinces in Canada have a major educational institution or government division devoted to training people for, and carrying out research in, all aspects of agriculture. The majority of the universities and colleges in the United States (excluding the Atlantic seaboard universities) were founded as agricultural and mechanical institutes under the college land-grant system, indicating the extent of their early national interest in agriculture. Many private companies devote large sums of money to effective research in agriculture, resulting in improved machinery, fertilizers, feeds, crops, and methods. Research in fields not directly related to or connected with agriculture, meteorology and climatology among others, make important contributions to agriculture. The gratifying progress in agriculture speaks well for the scientific approach and augurs well for what can be done if a comparable level of well planned research activity is achieved in fisheries.

Fisheries science has received earnest attention from a very few countries, much of the effort being in the recent past. Fisheries research in Canada is carried out almost exclusively by the Federal Government, and even now at a modest level. The Federal Department of Agriculture, which carries out approximately 70% of the agricultural research in Canada, devotes four times as much money to this as is spent on fisheries research.

Why has agriculture enjoyed widespread support in contrast to fisheries ? The basic reason is that prior to 1900 up to 80% of the populations of Canada, the United States, and most other countries were directly engaged in agriculture. Consequently, the interest in agriculture, and pressures for improvements, were immense. It is only within the past 30 to 50 years that the number of people directly employed in agriculture has tended to become a minority. This situation has been brought about directly through increased productivity resulting from research effort that was, and still is, of enormous scope. The smaller numbers of people engaged in fisheries, and the existence of certain apparent difficulties unique to fisheries, have militated against the development of fisheries research. Some aspects of fisheries research, such as physical and biological oceanography, and experiments in the natural environment, admittedly are expensive. The costs of many other aspects involving "wet" and "dry" laboratories compare favourably with those of agricultural or other lines of research. Additional and adequate support of fisheries research should produce benefits of the same order as those achieved in agriculture. Certainly the potential is there, and a research program wisely formulated and vigorously pursued will produce solid results which could make our aquatic environment as important as any resource we possess.

In technical matters Canada's fisheries have made great strides in breaking away from the traditional techniques of the past, particularly since World War II. We have moved from two-masted schooners to highly mechanized stern trawlers. Purse seiners are adding to the Atlantic herring harvest previously obtained from primitive shore-fishing weirs. New fish processing plants are now becoming show places in the food-processing industry.

Living resources in the water, however, have not yielded to engineering techniques which seem adequate elsewhere. Two examples will illustrate : The salmon hatcheries reached their crest of popularity a half century ago and were efficient as to percentage hatch, yet they did not enhance the salmon stocks. Only now are rational rearing procedures

reaching the pilot plant stage. Secondly, there recently arose in Europe a conviction that commercial fishing gear, which had been developed by tradition, could be greatly improved by application of modern engineering principles. The new gear was easier to handle but did not notably result in increased catches of fish. The behaviour of fish towards objects in the water was not, and still is not, understood. It would seem that the old equipment had represented a successful empirical compromise.

The generalization from all this, which goes far beyond fisheries, is that knowledge about the behaviour of animals has been a persistent puzzle to the human mind, Research on problems of behaviour has found small support from governments and small approval from professional scientists in other fields, who prefer more precise-sounding projects.

Assignment of a dollar value to research is avoided by many scientists because it too readily invites masquerade. It is, however, possible to state that the numerous FRB discoveries that are applicable to fisheries, such as those leading to the development of new fisheries, and to improvements in preservation of fish, have more than paid for all FRB fisheries research. A specific example evaluating a modification in industrial practice brought about through FRB efforts is the introduction of the use of refrigerated sea water in the salmon fishery on the west coast. When implemented to its full potential, this procedure alone can result in an annual saving equal to the annual cost of operating the Board's Vancouver Laboratory.

The sea is a common property resource; hence individual Canadians have no adequate incentive to invest in the husbandry of its wealth and potential. For this reason, and because of the fragmented nature of the industry, there is no real alternative to government sponsorship of fisheries research. Industry participation is limited to some product and equipment work by the larger companies, and trials with new or modified gear by occasional enterprising fishermen.

The Industrial Development Service of the Department of Fisheries assists in these applications. Universities do some basic research which varies according to location and staff interests. Provinces and International Commissions deal with certain species (e.g. trout in most inland waters, Pacific halibut, two species of Fraser River salmon). However, the Fisheries Research Board of Canada has unique responsibilities in developing research in the broad field of fisheries in Canada which have been assigned by Act of Parliament.

With its relatively small population, Canada cannot afford to emulate the United States or the Soviet Union in lavish support for all branches of science. Canada's resources in men and money, its geography and its needs, all force it to specialize and try for outstanding achievement in limited fields. Fisheries science is an opportune field since Canada has :

- a long sea-coast on three oceans, more fresh water, and ready access to more aquatic renewable resources than almost any other country.
- an established position among the world leaders in fisheries research, which can be maintained and enhanced through continued strong effort.

III. CLIENTS

Some scientific boards, like Defence, presumably exist solely to serve their ministries. Others, like the Medical Research Council, are totally separated. The major part of the FRB budget is for the direct use of the Ministry but its fairly wide outside connections also warrant mention.

Ministry of Fisheries. Sixteen or more nations fish the Western North Atlantic and at least four fish the Eastern North Pacific. To provide management and conservation there have been several treaties under which International Commissions have been set up. The FRB provides research and scientific advice to Canadian delegations for

most of these bodies. Within Canadian waters the conservation regulations for such forms as lobsters, oysters, herring and salmon are based partly on information supplied by FRB research. In fact FRB research plays a role, directly or indirectly, in the management of all marine commercial fisheries in Canada as well as sport fisheries in the Atlantic region. Much useful information is in turn derived by FRB scientists from activities of the Department of Fisheries.

The Fishing Industry. Since 1924 industry representatives have been active members of the FRB. Concurrently laboratories were established for the development, in close collaboration with industry, of improvements in the preservation and processing of fish, and of new products from fish. The biological search for new stocks of fish to be exploited, and for means of increasing stocks of lobsters, salmon, etc., is also of direct use to industry.

Defence. The FRB has a strong interest in oceanography which defines the environment of the fisheries. This interest is designed to develop information about the boundary conditions of water masses. These have equal relevance to fish behaviour and to submarine detection. In the Pacific FRB oceanographers still carry military responsibilities in addition to fisheries. Valuable vessel facilities are made available to the FRB by the Department of National Defence as well as other government agencies.

Northern Affairs. A 1953 Bill gave this department coordinating responsibility. The FRB offers research and advice on productivity of northern waters and the sustaining capacity of lake fish stocks for Eskimo and Indian settlements.

International Joint Commission. Biological aspects of such questions as the Passamaquoddy Tidal Power Project and Great Lakes Pollution are investigated by the FRB.

Universities. The FRB has on occasion made its ships, laboratories and field stations available for research by qualified academics. It also operates a modest grant program designed to assist certain university departments to improve the opportunities for graduate students to undertake theses in aquatic science.

The Provinces. West of New Brunswick and south of the Territories the stocks of fish in inland waters are provincially managed, but FRB has always done considerable freshwater research on basic problems that are applicable to management. The provinces do virtually no product research.

Canadian Committee on Oceanography. The FRB was one of the founding members and provides the executive secretary.

IV. THE PRESENT PROGRAM

The key paragraph of the Fisheries Research Board Act is furnished on page 1 of this appendix. Under the Act the FRB is given responsibility to develop the biological aspects of aquatic science in Canada and to investigate practical fisheries problems. The FRB research program is in five main areas. These will be discussed in turn.

The Environment is approximately equivalent to oceanography and its freshwater counterpart, limnology. It includes the properties, structure and behaviour of waters, phyto- and zoo-plankton, plant and animal production processes and energy relations in the food chain, and effects of artificial alteration of the milieu (stream channel alterations, dams, insecticides, sewage, industrial wastes).

The Resource is concerned with commercially useful organisms of all sorts : their form and structure, physiology, biochemistry, life history, behaviour under different conditions, reproduction, diseases and parasites. At the level of stocks or populations information is needed on reproductive success, mortality rate, food, growth

rate, stock size, and effects of competition and of environmental conditions.

Increasing the Resource includes the current encouraging development of controlled-flow spawning channels and improved hatchery procedures for propagating salmon. On the Atlantic coast oyster hatchery practice has been improved and lobster holding and feeding in pounds has been greatly assisted by recent FRB developments.

Transplantations have a tantalizing history. On the credit side are the transplantations of Japanese oysters and Manila clams to British Columbia. Still in the experimental stage are transfers of sockeye and coho salmon to the Great Lakes and pink salmon to the Atlantic, and of lobsters to British Columbia. Future possibilities include other species of salmon, European oysters and sturgeons.

FRB research has indicated that lobsters can survive on our Pacific coast -- the experiment is still in progress. Pacific pink salmon have been introduced outside their geographic range to a Newfoundland river and some have bred there. They have also been transplanted to off-year streams in British Columbia, but in spite of numerous efforts over some 60 years no self-supporting pink salmon populations of any magnitude have as yet been established in Canada or elsewhere unless possibly in northern USSR. The economic stakes in this game are so large that the FRB will continuously review this approach. If progress is to be made with most species it will be necessary to develop additional fundamental studies on food cycle dynamics. The FRB basic researches into primary productivity are designed to open up this area.

Harvesting and Management research includes three types of work. Exploration for new stocks, or concentrations of commercial density, is carried out, often in collaboration with the Industrial Development Service of the Department of Fisheries. To understand why a fishing method is or is not successful depends on knowledge of

the behaviour of fish in relation to gear. This involves their sensory capabilities and capacities, swimming ability, reactions to objects or chemicals, and the design of the fishing apparatus. Management studies involve determining the effect of fishing on stock size and productivity, means of forecasting catches, and estimating sustainable yields.

The decisions of industry concerning expenditures for ships and plants depend upon estimates of the sustained yield of a species. The possibilities and limits of new and expanded fisheries such as that for Atlantic herring or for Pacific bottom fish are defined by management research.

In addition to work on strictly domestic fisheries, this FRB research supplies background information for the nation's international commitments. This includes seals and the perilously reduced baleen whale stocks. Studies of fish distribution and fluctuations in abundance, and the prediction of fish concentrations, provide the information used in Canada's negotiations with other countries to determine the fisheries position of tomorrow. The trend of our industry is to utilize new species and smaller sizes of fish than hitherto. Premature acquiescence to international restrictions based on inadequate research could hamper further development of fisheries or deplete existing stocks.

Harvesting research, together with the population aspects of resource research, tend to be the most expensive of FRB program components. They involve field work and branch laboratories, technicians, ships and crews. In these areas the cost per scientist is about three times that of laboratory-based research. The overriding need to know more about living resources justifies this expenditure.

Commercial Products. It is likely that a great increase in demand for fish will occur in North America whenever the housewife can buy fish in the supermarket with as much confidence as she now buys eggs, ham or cheese. Considerable success in this direction has been achieved with lean fish like haddock. The prevention of rancidity in

fatty fish has been more troublesome but good progress is being made. Antibiotics have had a major impact on the Atlantic fresh fish industry. New preservative methods, such as ionizing radiation and superchilling, are being developed in advance of commercial needs, and new chemical preservatives, such as metal binding agents, are being exploited. New products, such as fish protein concentrate, have also been created and at a recent conference with worldwide attendance the pioneering role of the FRB in this field was acknowledged.

In conjunction with the industry, methods of freezing fish at sea were introduced, as well as the use of chilled sea water (an FRB discovery of the 1920's which reached commercial use in the late 1950's). Bacterial and bio-chemical changes are thoroughly investigated in all of these processes.

The rapidly expanding fish meal industry has benefited substantially, through higher prices, by nutritional studies on these products carried out by the FRB on the West Coast and now in progress on the East Coast.

V. AREAS REQUIRING EXPANSION

The present program of the FRB uses available financial and human resources completely and any new development is accompanied by some curtailment elsewhere. Exigencies arise continuously, such as that resulting from the new foreign salmon fishery off Greenland. Preliminary tagging indicated that large numbers of these salmon came from Canadian rivers and Canada could hardly stand idly by while other nations investigated the resource, assembled the evidence, drew the conclusions and harvested the crop. An immediate diversion of staff and vessel time was made, disruptive to existing work, and only partly overcome by belated augmention of technical help as regulations permitted.

The salary scales for scientists are increasing and must be kept competitive with United States offers. Apparatus costs are also growing, largely due to the greater complexity of equipment used in

modern sciences. If the Board is to continue its existing scope and level of research with modern instrumentation, a cumulative increase in operational expenses of about 11 per cent annually is required. The topics which follow demand expansion beyond this maintenance level. Flexibility and adaptability are required to benefit from programming which originates continuously from new scientific advances.

The Environment. In the depths of the open ocean there is a "deep scattering" layer. The name arises from the signals reflected to sonic detection apparatus on board ships. Large numbers of fish may be associated with this layer but so far no one has been able to make any commercial use of them. Ships and the development of sensing apparatus and gear will be required to explore this and other new segments of the environment. Any country which can make this potential crop available to its industry will reap strong economic advantages.

Contamination of the Great Lakes and other inland waters is another pressing problem of the times. Under a charge from the International Joint Commission, a multi-discipline effort was launched to investigate (and eventually alleviate) this pollution. In addition to the Province of Ontario, the federal agencies concerned are : Energy, Mines and Resources (water quality, circulation, chemistry), National Health and Welfare (fitness for human use) and the Fisheries Research Board.

The FRB task is to understand the mechanism and the biological effects of man-made increases in the nutrient level of lakes and to seek efficient means of controlling the process. It is analogous to the medical problem of a widespread ailment like rheumatism, for which no alleviation has been discovered beyond aspirin and massage. The research will include field studies on the Great Lakes, laboratory studies, and pilot plant operations on smaller lakes. The Great Lakes situation, basically a rescue operation, affects nearly half of Canada's population.

In order to maintain the fisheries the federal government has a direct interest in preserving the aquatic environment from pollution.

This coincides with the maintenance of quality for such recreational uses as boating, swimming and sport fishing. The FRB must define the pollution limits which are deleterious but not necessarily lethal to fish. This effect includes inhibition of growth and damage to embryos, food supplies and shelter. Indicator organisms have been discovered whose disappearance from bodies of water gives evidence of the presence of particular pollutants. This is a study area to be expanded. Proposals for anti-pollution control and for research under the IJC Great Lakes pollution were detailed in a memorandum to Cabinet (October, 1966).

The Resource. Dramatic changes are taking place in Atlantic fish stocks. The larger sizes of bottom-living species such as cod which have traditionally been the main resource are disappearing with a corresponding requirement of change in methods used by the industry. It appears unlikely that the groundfish catch can be much further increased. The trend today is to turn to pelagic fish, notably herring, for which a new market, as meal, has opened up and in which there have been spectacular increases in catch.

The future expansion of the Atlantic industry appears to depend upon the harvesting of additional species and smaller sizes by new methods. Additional animal protein is there, available for use by a hungry world, but the places of concentration of new stocks and their sustainable annual yields remain to be worked out. The energy relations are complex since some of the potential unused fish resources (e.g. capelin) are the food of species now being captured. The FRB has projected plans to study in depth the population dynamics of migratory pelagic fish, especially the herring. These plans require increased staff and costly ships.

Looking closer to shore, lobsters bring almost the same amount of money to fishermen as Pacific salmon and application of science to management offers about equal chances of increasing the value of the two resources. However the lobster fishery is under

Canadian control, and, with almost two-thirds of the world's supply taken in our eastern provinces, is nearly a Canadian monopoly.

The Board does not have the basic knowledge of lobster physiology necessary to deal with the serious blood disease, gaffkaemia; to reduce the substantial losses among lobsters held in pounds or shipped live; to grow lobsters economically in captivity; to develop artificial reefs and shelters for lobsters on new grounds; and to control moulting. We would be caught off balance should a natural period of population decline set in, and must make strong increases in our basic research towards understanding this valuable species.

Increasing the Resource. There is a pressing problem and opportunity in British Columbia salmon. The Fisheries Resource Development Branch of the Department and the FRB have recently prepared reports concerning their respective areas of action. Experiments to increase the size of stocks in particular rivers are mostly still in progress. When dealing with populations whose natural abundance and mortality fluctuates violently for reasons not yet understood, the experimenter is beset with difficulties in assessing the effect of treatments.

We are not yet in a position to recommend wholesale construction of new hatcheries or spawning channels. The FRB must invest much more in our defined area of fundamental understanding of the basis for survival of eggs, young fish in streams, and maturing fish during their time at sea.

Harvesting and Management. Research in this field was formerly framed around engineering and dealt with the efficiency of mechanical devices. The biologist, asked to relate fish to gear, is today in about the position that Faraday would have been in had he been asked to design a power station while still trying to work the relation between electricity and magnetism. It will be necessary to begin with intensive studies of the reactions of fish concentrations to mobile and

stationary objects as well as the effects of chemical attractants and repellants, and light, electricity and sound. The plan proposes that this research would be based on one of the FRB Atlantic stations adjacent to a suitable body of enclosed water suitable for field studies.

The instrumentation problem is crucial to harvesting. If we are to compete scientifically with terrestrial agricultural research we must, in effect, make the ocean transparent. Neither divers nor TV are practical with full-scale tests -- the speeds, depths, and technical limitations are too great a handicap. FRB plans include the development of new acoustic sensors, coupled with computers to analyze the fish counts. For direct observation we shall also develop and use, as necessary, underwater vehicles, both towed and self-propelled.

Commercial Products. Increased research is needed to trace the deterioration of quality observed by the consumer back through handling and processing steps to the physiological condition of the fish when caught. Quality control, well recognized in the manufacturing world, is equally essential in fisheries.

Effort must be increased in certain areas of product research. The ocean teems with a variety of living organisms of types not found on land. In addition to food these plants and animals can provide us with natural products, biosynthetic processes, and a better understanding of the basic mechanisms of life. Some natural products are being harvested now, but the full exploitation of this resource has scarcely begun. A knowledge of substances present in marine forms is a prerequisite to intelligent utilization of the resource. There must be a continuing investigation of means of utilizing species which at present are unexploited, and are in some instances troublesome.

VI. THE COMMON NEED : WATER LABORATORIES AND RESEARCH VESSELS

The field of natural resource research has seemed since the war a little old-fashioned and outside the vanguard of science which is depicted in terms of particle accelerators, rockets, radio telescopes and similar apparatus. In fisheries, as elsewhere, our successes have been in the application of physical science and our failures due to a lack of knowledge of behaviour and general physiology of marine organisms.

The physical requirement for this research is provision for scientists to observe fish in their native habitat with enough surrounding space to freely permit their normal reactions to each other and to external objects. Biologists have had some success in the control of stimuli for those sense organs with which man is well equipped, but have had great trouble with experimental design in areas where humans are relatively weak, such as odour perception. The constancy and adequacy of water supplies require close attention in laboratories. The FRB already has special competence in the operation of water laboratories and recent FRB studies using these laboratories for controlled experiments have shown that the physiological condition, when caught, of valuable species such as cod, lobsters, and oysters, can affect the commercial value of the ultimate product. Water laboratory studies have also recently shown that the physiological state of marine organisms affects their reproduction and the subsequent survival of juvenile forms to sizes of interest to commercial fisheries.

FRB scientists have, on each coast, the use of a research vessel of the otter-trawler type intended primarily for exploratory fishing. There are also a number of smaller inshore vessels. A modest amount of time for oceanographic research is provided through the courtesy of other Government agencies. This makeshift situation is incompatible with the serious vessel time needs of current FRB scientists and does not allow for more than occasional participation of university staff and students.

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Physical oceanography is now highly automated but space and gear needs are such that equipment is no longer portable but must be installed on a semi-permanent basis. Biological oceanography has greatly altered in late years and now requires increasingly complex electronic and other equipment, while the sea-going biologist is no longer content to preserve specimens in formaldehyde for future examination, but wishes to transport live animals ashore for immediate detailed study.

It is necessary to think in terms of several vessels of various types for each coast, some of which would be large enough both for deep sea operations and for fitting out with elaborate permanent equipment and laboratories. This is a more efficient procedure than attempting to design a relatively small vessel suitable for all research interests or continuously altering the research characteristics of a vessel to suit a few individual programs, and also allows for integration of university staff and student projects without unduly disturbing long-term FRB research. It is recognized that the greatest cost of increasing the population of post-graduate students in our universities is that of providing the students and teaching staff with opportunities for research. The proposed FRB water laboratories and research vessels would offer a strong and nation-wide enlargement of academic opportunity to train recruits for an important area of science. Sharing facilities with universities will stimulate the whole scientific community.

VII. INCREASED OPERATING COSTS AND SCIENTIFIC MANPOWER

The five objectives for increased fisheries research will require an increase in annual operating expenditures from $11 million to $40 million over the next ten years. This will provide the higher operating costs of expensive capital equipment, recruitment of a doubled scientific and support staff, and the university-support program necessary to train staff for recruitment to fisheries science.

Scientists make up about 32% of the present staff, the remainder being technical, administrative, clerical, and ships' crews.

This ratio is expected to continue. Recruitment requirements for scientists are forecast at about 30 (± 5) per year. It is expected that the FRB can find and recruit suitable scientists at about this rate. (Authorized appointments under the International Joint Commission inter-agency pollution reference are additional to the above).

It is estimated that over the next ten years, the Board will require a cumulative growth of approximately 5% in staff and 14% in operating costs per annum. This amounts to projected total annual operating costs of $40 million by 1977.

TABLE I and FIGURE, Pages 23,24.

VIII. INCREASED CAPITAL PROGRAM

The physical facilities of FRB have not kept pace with growth. In many areas, buildings put up for other purposes many years ago are found to be increasingly unsuitable. In most areas, staff are crowded substantially beyond minimum government standards.

Over half of the planned construction is concerned with adding to or modernizing research facilities for staff accommodation at strengths already approved. The emphasis in all research facilities has been shifting to laboratory-type operations and young scientists are increasingly insistent on adequate laboratory facilities. The FRB, therefore, must modernize its laboratories and equipment to remain competitive for good scientific employees.

The present plan attempts to avoid the uneconomical approach of constructing buildings that prove too small by the time they are ready for occupancy by projecting a growth factor of about 5 per cent per annum.

Fisheries research requires expensive floating platforms (ships) at sea and on large lakes. The economy and simplicity of chartering vessels is preferred where possible, but will not serve for continuous specialized operations.

The present FRB fleet numbers 15. Only three vessels are over 100 feet in length and are truly ocean-going ships. The remainder are limited to operations in fair weather and inshore waters. Six additional large vessels are planned for construction in the next ten years. An additional need is also foreseen for inshore vessels and submersible vehicles.

Capital costs for a phased program of water laboratory and research vessel construction, and acquisition of capital equipment, will require an average annual expenditure of about $10 million for many years to :

(a) replace old, crowded, out-dated laboratories and research vessels;

(b) add offshore research vessels for biological research and fishing efficiency studies;

(c) add water laboratory facilities for the fish behaviour and physiology research necessary to understand anti-pollution, resource distribution, harvesting, resource enhancement, and product quality problems;

(d) add better scientific equipment for increasingly more detailed research.

These facilities are needed to satisfy the expanding responsibilities for federal fisheries research, and to meet the needs of selected universities for expensive research vessels and water laboratory facilities which academic institutions find costly and difficult to manage.

A detailed capital submission has already been approved in principle by the Treasury Board. Table II (page 25) summarizes this approved capital program and brings up to date the capital requirements forecast as necessary to execute the full scope of FRB planning for the next decade.

TABLE I

FORECAST ANNUAL OPERATING COSTS AND MAN-POWER *

(in thousands of dollars based on 1967 costs)

	PRESENT 1967-68			FORECAST 1977-78		
	$000	Man-Power		$000	Man-Power	
		Sci.	Non-Sci.		Sci.	Non-Sci.
The Environment	1,840	50	104	7,700	100	200
The Resource	2,796	73	151	6,300	80	165
Increasing the Resource	1,612	34	97	7,000	90	200
Harvesting & Management	2,381	44	153	8,750	110	250
Commercial Products	1,210	46	45	5,250	70	130
SUB-VOTE	9,839	247	550	35,000	450	945
Grants & Scholarships	410		1	3,000		3
Office of the Chairman	395	10	17	1,000	13	30
Office of the Editor	285	4	8	1,000	7	22
GRAND TOTAL	10,929	261	576	40,000	470	1,000

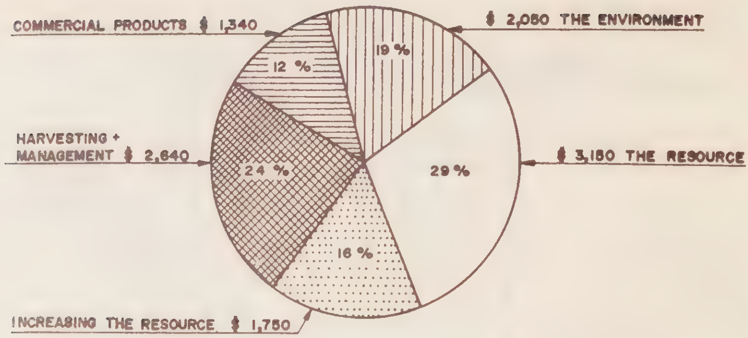
* Operating Costs

Forecast provides a compounded annual rate of growth of approximately 14%.

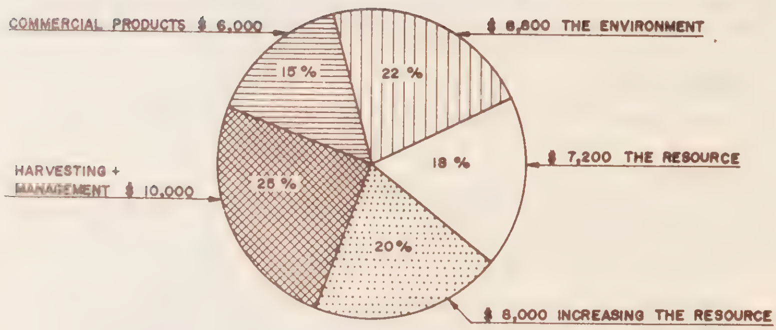
Man-Power

The heading "Non-Scientists" includes Technicians, Ships' Officers, Ships' Crews, Administrative, Clerical, Stenographic, and Maintenance Staff.

Casual employees (students, relief ships' crews, other assistants) will be required in addition to the numbers of full-time staff forecast above in an amount of approximately 10% of the total.



OPERATING COST FOR FRB AREAS OF RESEARCH 1967-68
(THOUSANDS OF DOLLARS)



FORECAST OPERATING COSTS FOR FRB AREAS OF RESEARCH 1977-78
(THOUSANDS OF DOLLARS)

TABLE II

FRB CAPITAL PROGRAM & FORECAST FOR NEXT 10 YEARS
(in millions of dollars based on 1967 Construction Costs)

	Present (1967-68)	Approved by Treasury Board (Cumulative Total)	Revised Cumulative Total
Equipment	1.1	15	20
Buildings	2.3	37	40
Water Laboratories	0.3	5	15
Research Vessels	0.2	13	25
TOTAL	3.9	70	100

Treasury Board Minute T.B. 666959, dated May 29, 1967, gave approval in principle of an FRB Ten-Year Phased Construction Program totalling approximately $70 million.

SOME GUIDELINES FOR PROMOTIONS OR RECLASSIFICATIONS

(1) Research productivity and quality as shown by publications, reports and in other ways: for example, invitations to contribute to symposia, reviews, etc.

(2) Assistance and 'inspiration' given to others working in the same or other Stations.

(3) Administrative and leadership performance.

(4) Contributions to the work of the Ministry (management programs, national and international committees and organizations, etc.).

(5) Activity in national and international scientific societies.

(6) Effectiveness in 'popularizing' fishery science among non-scientists.

(7) Reference to the average salary treatment of scientists of similar university training throughout the Board and comparable agencies, as a norm from which individual performances are to be measured.

O T T A W A,
June 30, 1967.

APPENDIX V

A Proposed Scholarship Program for Educational Leave

1. PROCEDURE

Applications for educational leave for the purpose of obtaining a university degree and for enrichment and diversification of experience, supported by the employee's Director, may be granted subject to the following general conditions. All requests will be reviewed by a committee of senior staff appointed by the Chairman. The recommendations of this committee are subject to ratification by the Executive Committee of the Fisheries Research Board.

The Senior Staff Committee will meet in advance of normally scheduled meetings of Board Executive. On other occasions, when Executive Committee meetings do not coincide with staff requirements for educational leave, the responsibility for ratification may be delegated to other appropriate bodies such as the University Grants Committee or the Chairman of the Fisheries Research Board. Sufficient advance notification of these meetings will be provided to allow adequate time for preparation of applications.

2. FINANCE

Employees granted educational leave entailing continuance of financial support will remain in staff positions on the establishment of the Station in which they are employed, and scholarship payments will be made monthly. Any approved travel or other expenses will also be charged to the appropriations of that Station.

3. ELIGIBILITY

Educational leave normally may be granted to staff members who have completed at least two years service with the Board and who have demonstrated research ability. The academic advancement obtained by the employee while on leave is intended to qualify him for career development. The primary objective of this program should be the up-grading of scientific staff, and educational leave will normally be granted only to staff members of high potential who wish to acquire a Doctor's degree.

4. REMUNERATION

(a) Educational leave will normally be granted under the financial terms of the FRB Scholarship program. The basic scholarship stipend is $4,000 per annum with additional allowances, where appropriate, of $1,200 per annum for the employee's wife and $50 per month for each child up to a maximum of three. Tuition fees up to a maximum of $700 in Canada will also be provided. Individual consideration will be given to applications for payment of university tuition fees outside Canada which are in excess of $700.

(b) Leave without pay may be granted where an applicant does not meet the above requirements of scholastic ability, potential development etc.

An employee on educational leave may, at the Director's discretion, return to full salary during any prolonged absence from university in which he is engaged upon full-time Board work at, or associated with, a Board Station.

5. TRAVEL ALLOWANCES

A travel allowance based upon one full return economy air fare or equivalent will be provided. In addition, two-thirds of this amount will be granted to a married employee who is accompanied by his wife.

6. LEAVE CREDITS

Vacation, sick and special leave credits continue to accrue for employees on educational leave under the scholarship program.

Employees on educational leave without pay will be subject to the usual leave without pay regulations governing leave credits.

7. PERIOD OF LEAVE

Educational leave may be approved for a maximum period of one year at a time. In the event that the course of studies which the employee wishes to take will extend beyond one year, a new application for an extension must be made. It is important that, when the original application for educational leave is made, it be clearly indicated what period of time may be required by the employee to complete his educational program.

If the program will require more than one year and if reports are received from the university that satisfactory progress has been made in the first year, a renewal of educational leave for a second year may logically be anticipated. However, if reports do not indicate satisfactory progress, educational leave for the second year may be refused.

8. EFFECTIVE DATE OF EDUCATIONAL LEAVE

An employee having vacation leave credits may use these credits in order to remain on full salary from the date of his last working day to the expiry date of his leave credits, at which time he will revert to scholarship rates or leave without pay; otherwise educational leave will be in effect from the day following the last working day to the day of returning to duty.

9. SALARY DEDUCTIONS

An employee who has been granted educational leave under the Scholarship Program or leave without pay will be required to pay, for the period of absence, superannuation contributions at the normal rate of 6½ per cent (5 per cent for female employees) of his full salary at the time of commencing leave.

10. PROMOTIONS

Following completion of educational leave employees will have their salaries reviewed, and adjustments proposed in relation to their new responsibilities with the Board.

11. OTHER FINANCIAL ASSISTANCE

An employee granted educational leave may also accept a university scholarship and/or an appointment as lecturer or demonstrator, provided that his course of study will not be appreciably prolonged and that the scholarship is not awarded by an agency or department of the Public Service of Canada. Information concerning the amount of time to be spent in such university employment should be obtained in advance of making an application and requires Board approval.

September 12, 1968.

APPENDIX VI

SABBATICAL LEAVE

The purpose of sabbatical leave is to stimulate, improve, and broaden the research competence of the FRB scientist by bringing him into close association with leaders in his field from outside the FRB organization. Programs undertaken during sabbatical leave might include: research at other institutions; visits to up to four research institutions to exchange ideas and become familiar with current research at those locations; completion of major research reports in a suitable environment while relieved of other responsibilities; study under recognized authorities in specialized fields, to acquire knowledge which may be necessary in carrying out proposed research for FRB; or similar activities.

A scientist who has been continuously employed with FRB for over six years may apply through his Station Director for sabbatical leave. Applications should be submitted at least six months in advance of the planned date of departure. Station Directors should forward applications they receive to the Chairman, with their comments and recommendations. Each application will be judged on its merit with respect to the length of service of the applicant, the scientific productivity of the applicant and the potential benefit to FRB and the scientist. Normally, sabbatical leave will be for a period of from six to twelve months. The Executive Committee of the Board has the final authority in determining whether or not a request for sabbatical leave is approved.

A scientist who receives sabbatical leave is expected to remain with FRB for at least a full calendar year after his return to the station.

Where no other income is received or accepted in relation to the period of sabbatical leave, a scientist will receive his full normal salary. If the scientist receives an award or grant, the amount of such award or grant will be deducted from his salary.

A scientist, and his wife if she elects to accompany him, may receive full economy air fares from the station to the location where he will spend his sabbatical leave. There is no authority to pay for, or

contribute to, the costs of travel incurred by any other relative who may accompany the scientist on sabbatical leave, except his wife.

Station Directors have discretionary authority to pay transportation expenses for related side trips taken by a scientist while on sabbatical leave.

No reimbursement can be made for living expenses incurred by a scientist or his family while on sabbatical leave.

The Executive Assistant or Personnel Administrator should alert a scientist leaving the country for an extended period of time to the fact that his provincial hospital insurance may not provide coverage during his entire absence. If the provincial insurance does not provide out of country coverage, the scientist proceeding on sabbatical leave should be informed in advance of the Federal Government Hospital Insurance (Outside Canada) Plan, to which employees stationed abroad may subscribe. This plan, which provides for payroll deduction of premiums, offers coverage similar to that provided by the Ontario Hospital Services Commission.

The Group Surgical-Medical Insurance Plan provides protection outside of Canada in the same manner as it does to persons in Canada.

O T T A W A,
January 9, 1968.

APPENDIX VII

Current Scientific Personnel Establishment and Strength, October 1, 1968

Station	Establishment	Strength Total	B	M	D	Post Doctoral Fellows	Staff primarily inv'd in Admin. Duties
St. John's(inc. St.John's Tech)	22	20	6	9	5	0	1
Dartmouth	21	18	1	6	11	1	1
Halifax	41	36	6	14	16	1	1
St. Andrews	33	31	2	7	22	0	3
Ste. Anne	10	10	0	2	8	0	1
Ottawa	11	10	0	1	9	0	7
Winnipeg	37	27	3	3	21	2	2
Vancouver	28	27	11	3	13	1	1
Nanaimo	51	49	5	18	26	1	3
Gr. Riviere	4	3	1	2	0	0	1
TOTAL:	258	231	35	65	131	6	21

APPENDIX VIII

COUNTRIES OF BIRTH OF PROFESSIONAL PERSONNEL

ACCORDING TO HIGHEST UNIVERSITY DEGREE LATER RECEIVED

Country	Bachelor	Master	Doctorate	Total
AUSTRIA				-
BULGARIA		1		1
CANADA	25	39	65	129
CEYLON			1	1
CHINA			5	5
CZECHOSLOVAKIA			1	1
EGYPT	1		1	2
FINLAND		1		1
FRANCE				-
GERMANY		3	3	6
HUNGARY		1		1
HONG KONG	1			1
INDIA	1	1	3	5
INDONESIA			1	1
ISRAEL				-
ITALY			1	1
JAPAN			2	2
NETHERLANDS		1		1
NORWAY		2	1	3
PHILLIPINES	1			1
POLAND			5	5
ROUMANIA			1	1
S. AFRICA			2	2
SWITZERLAND				-
TAIWAN		1		1
U.K.	2	12	22	36
U.S.A.	1	4	18	23
U.S.S.R.		1	1	2
URAGUAY		1		1
WEST INDIES		1	1	2
TOTAL	32	69	134	235

APPENDIX IX

Countries where professional personnel received their secondary schooling according to highest university degree later received

COUNTRY	BACHELOR	MASTER	DOCTORATE	TOTAL
AUSTRIA				
BULGARIA				
CANADA	26	44	73	143
CEYLON				
CHINA			3	3
CZECHOSLOVAKIA			1	1
EGYPT	1		1	2
FINLAND		1		1
FRANCE				
GERMANY		1	3	4
HUNGARY		1		1
HONG KONG	1			1
INDIA	1	1	3	5
INDONESIA				
ISRAEL		1		1
ITALY			1	1
JAPAN			2	2
NETHERLANDS		1	1	2
NORWAY		2	1	3
PHILLIPINES	1			1
POLAND			5	5
ROUMANIA				
S. AFRICA		1	2	3
SWITZERLAND				
TAIWAN		1		1
U.K.	2	8	18	27
U.S.A.		5	18	23
U.S.S.R.		1	1	2
URAGUAY				
WEST INDIES		1	1	2
TOTAL	32	69	134	235

APPENDIX X

Countries where professional personnel received their highest university degrees *

COUNTRY	BACHELOR	MASTER	DOCTORATE	TOTAL
AUSTRIA	-	-	1	1
BULGARIA	-	-	-	-
CANADA	27	49	60	136
CEYLON	-	-	-	-
CHINA	-	-	-	-
CZECHOSLOVAKIA	-	-	1	1
EGYPT	1	-	-	1
FINLAND	-	1	-	1
FRANCE	-	1	-	1
GERMANY	-	-	3	3
HUNGARY	-	-	-	-
HONG KONG	-	-	-	-
INDIA	1	-	-	1
INDONESIA	-	-	-	-
ISRAEL	-	1	-	1
ITALY	-	-	1	1
JAPAN	-	-	3	3
NETHERLANDS	-	1	2	3
NORWAY	-	1	1	2
PHILLIPINES	1	-	-	1
POLAND	-	-	3	3
ROUMANIA	-	-	-	-
SOUTH AFRICA	-	-	1	1
SWITZERLAND	-	-	1	1
TAIWAN	-	-	-	-
U.K.	2	5	22	29
U.S.A.	-	10	35	45
U.S.S.R.	-	-	-	-
URAGUAY	-	-	-	-
WEST INDIES	-	-	-	-
TOTAL	32	69	134	235

* Where a person had two or more degrees of the same stature, the country where the most recent degree was obtained was used in this compilation.

APPENDIX XI

Statistics on number of working years since graduation, number of years in present service, average age of employees and number of employees who are able to operate effectively in the two official languages.

		BACHELOR	MASTER	DOCTORATE	TOTAL
Average number of working years since graduation		$\frac{448.3}{32}$ = 14.0 yrs.	$\frac{907}{69}$ = 13.1 yrs.	$\frac{1783}{134}$ - 13.3 yrs.	$\frac{3138.3}{235}$ = 13.4 yrs.
Average number of years employed in present organization		$\frac{350.8}{32}$ – 11.0 yrs.	$\frac{705}{69}$ – 10.2 yrs.	$\frac{1256}{134}$ - 9.4 yrs.	$\frac{2311.8}{235}$ = 9.8 yrs.
Average age of employee		$\frac{1190}{32}$ = 37.2 yrs.	$\frac{2700}{69}$ = 39.1 yrs.	$\frac{5591}{134}$ = 41.7 yrs.	$\frac{9481}{235}$ – 40.3 yrs.
Number and percentage of employees able to operate effectively in the official language other than the mother tongue	SPEAK	1	9	21	31
	READ	13	40	86	139
	WRITE	4	13	24	41
Number and Percentage fully bilingual		1 or 3.1 %	7 or 10.2%	14 or 10.4%	22 or 9.4%

MOTHER TONGUE OF PERSONNEL BILINGUAL IN THE TWO OFFICAL LANGUAGES	
ENGLISH	8
FRENCH	4
GERMAN	3
POLISH	2
ENGLISH-CHINESE	1
BULGARIAN-HEBREW	1
LATVIAN	1
ARABIC	1
GUJARATI (INDIA)	1
	22

APPENDIX XII

Total numbers of professional staff, by laboratory, by highest degree held, for the years 1962 to 1968, with estimates of Board totals for the years 1969-1973.

B = Bachelor   M = Master   D = Doctor

Laboratory		'62	'63	'64	'65	'66	'67	'68	'69	'70	'71	'72	'73
St. John's	B	7	5	4	5	5	6	6	)				
	M	7	6	7	7	5	5	9	)22				
	D	3	3	3	3	6	6	5	)				
Dartmouth	B	2	1	1	0	0	0	1	)				
	M	1	3	3	3	5	5	6	)21				
	D	4	4	3	7	8	10	11	)				
Halifax	B	11	8	9	9	9	1	6	)				
	M	5	6	8	10	13	13	14	)41				
	D	8	11	11	13	14	15	16	)				
St. Andrews	B	1	2	3	3	2	2	2	)				
	M	7	6	6	7	8	9	7	)33				
	D	19	19	18	15	16	19	22	)				
Ste. Anne de Bellevue	B	0	0	0	0	0	0	0	)				
	M	2	2	2	2	2	3	2	)10				
	D	6	6	4	5	6	7	8	)				
Winnipeg	B	3	3	5	2	2	3	3	)				
	M	7	4	5	6	6	6	3	)37				
	D	6	6	5	5	7	14	21	)				
Vancouver	B	11	9	8	9	9	9	11	)				
	M	2	3	4	5	5	4	3	)28				
	D	8	6	7	9	9	12	13	)				
Nanaimo	B	5	8	5	6	6	5	5	)				
	M	17	17	19	18	18	21	18	)51				
	D	25	20	19	22	19	24	26	)				
Grande-Rivière	B	1	1	1	2	1	1	1	)				
	M	3	3	2	2	2	2	2	)4				
	D	0	0	0	0	0	0	0	)				
Ottawa	B	0	0	0	0	0	0	0	)				
	M	1	1	0	1	1	1	1	)11				
	D	4	4	4	6	7	8	9	)				
TOTAL		175	167	166	182	191	201	231	258	258	(277)	(309)	(304)*

* Figures in parenthesis based on projection contained in Appendix III, Table I.

APPENDIX XIII

Scientists with Bachelor, Master and Doctorate Degrees
who left FRB employment during years 1962-67

	1962 (185)*	1963 (196)	1964 (199)	1965 (221)	1966 (240)	1967 (261)
BACHELOR	2	5	4	5	5	2
MASTER	3	4	3	4	1	7
DOCTORATE	3	7	2	1	2	6
TOTAL	8	16	9	10	8	15
PERCENTAGE	4.32	8.16	4.52	4.52	3.33	5.77

* Scientific position establishment.

APPENDIX XIV

Numbers of scientific personnel, by laboratory, who at one time or another were employed by some other agency (university, government, etc.)

	Present Number of Professional Personnel	Employed by a University Prior to Present Employment	Taught in a University	Supervised Graduate Students	Formerly Employed by a Provincial Government	Formerly Employed by a Private Sector of Industry	Formerly Employed by Gov't of a Foreign Country	Formerly Employed by an International Agency	Formerly Employed by Another Agency of the Federal Gov't	Formerly Employed by Other Agencies
St. John's Station	15	1	4	2	4	-	1	1	1	-
Marine Ecology Laboratory	18	5	6	7	1	2	4	-	1	-
Halifax Laboratory	45	11	4	8	6	8	7	1	1	3
St. Andrews Station	31	5	2	10	2	2	4	-	2	2
Arctic Biological Station	10	4	3	5	-	-	2	1	-	1
Freshwater Institute	30	12	6	6	2	4	6	-	7	3
Vancouver Laboratory	27	6	-	3	3	6	2	-	1	1
Nanaimo Station	49	9	6	8	4	3	8	4	6	-
Headquarters	10	5	4	4	2	4	1	2	7	1
TOTAL AND PER CENT	235	58 24.7%	35 14.9%	53 22.5%	24 10.2%	29 12.3%	35 14.9%	9 3.8%	26 11.1%	11 4.7%

APPENDIX XV

Numbers of university students employed by FRB
by year and by laboratory

	1962	1963	1964	1965	1966	1967
St. John's, Nfld.	11	10	15	17	25	26
Dartmouth, N. S.	4	3	3	4	8	7
Halifax, N. S.	2	7	9	11	14	17
St. Andrews, N. B.	24	25	25	32	37	34
Ste. Anne de Bellevue, P.Q.	5	4	8	12	10	10
London, Ontario (now Winnipeg, Man.)	12	9	11	12	16	18
Vancouver, B. C.	1	7	8	7	7	8
Nanaimo, B. C.	28	33	33	46	47	48
TOTAL	87	98	112	141	164	168

APPENDIX XVI

Expenditures associated with scientific activities BY FUNCTIONS
(operating and capital expressed in thousands of dollars)

Year	INTRAMURAL R & D	DATA COLLECTION	SCIENTIFIC INFORMATION	SUPPORT OF R & D IN UNIVERSITIES	SUPPORT OF HIGHER EDUCATION	TOTAL
1962-63	3,994	2,742	160	23	26	6,944
1963-64	4,362	1,723	156	25	25	6,291
1964-65	5,314	1,813	205	44	29	7,405
1965-66	5,775	2,889	259	54	25	9,002
1966-67	7,419	3,545	328	250	9	11,551
1967-68	9,084	4,435	580	400	7	14,506
AVERAGE	5,991	2,851	281	133	20	9,276
% DISTRIB.	64.6	30.8	3.0	1.4	0.2	100.0

APPENDIX XVII

Expenditures Associated with Scientific Activities BY FUNCTIONS
1962-63 (Operating & Capital expressed in thousands of dollars)

STATION	INTRAMURAL R&D	DATA COLLECTION	SCIENTIFIC INFORMATION	SUPPORT OF R&D IN UNIVERSITIES	SUPPORT OF HIGHER EDUC. IN ENGIN. & SCIEN.	TOTAL
St. John's Biological	329	387	5	-	-	721
St. John's Technological	64	10	-	-	-	74
Halifax	398	37	11	-	-	446
Grande Riviere	104	9	-	-	-	113
Dartmouth	102	25	-	-	-	127
St. Andrews	668	239	9	-	-	916
Ste. Anne de Bellevue	242	83	5	-	-	330
Winnipeg	317	40	5	-	-	362
Vancouver	293	32	5	-	-	330
Nanaimo	1,397	1,850	11	-	-	3,258
Grants	-	-	-	23	-	23
Scholarships	-	-	-	-	25	25
Office of the Chairman	80	30	2	-	-	112
Office of the Editor	-	-	107	-	-	107
GRAND TOTAL	3,994	2,742	160	23	25	6,944

FISHERIES RESEARCH BOARD OF CANADA
OTTAWA,
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APPENDIX XVIII

Expenditures Associated with Scientific Activities BY FUNCTIONS
1963-64 (Operating & Capital expressed in thousands of dollars)

STATION	INTRAMURAL R&D	DATA COLLECTION	SCIENTIFIC INFORMATION	SUPPORT OF R&D IN UNIVERSITIES	SUPPORT OF HIGHER EDUC. IN ENGIN. & SCIEN.	TOTAL
St. John's Biological	341	415	6	-	-	762
St. John's Technological	63	10	-	-	-	73
Halifax	554	29	13	-	-	596
Grande Riviere	112	10	-	-	-	122
Dartmouth	118	29	-	-	-	147
St. Andrews	814	230	8	-	-	1,052
Ste. Anne de Bellevue	223	58	9	-	-	290
Winnipeg	333	31	6	-	-	370
Vancouver	286	44	7	-	-	337
Nanaimo	1,419	831	14	-	-	2,264
Grants	-	-	-	25	-	25
Scholarships	-	-	-	-	25	25
Office of the Chairman	99	36	2	-	-	137
Office of the Editor	-	-	91	-	-	91
GRAND TOTAL	4,362	1,723	156	25	25	6,291

FISHERIES RESEARCH BOARD OF CANADA
OTTAWA,
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APPENDIX XIX

Expenditures Associated with Scientific Activities BY FUNCTIONS
1964-65 (Operating & Capital expressed in thousands of dollars)

STATION	INTRAMURAL R&D	DATA COLLECTION	SCIENTIFIC INFORMATION	SUPPORT OF R&D IN UNIVERSITIES	SUPPORT OF HIGHER EDUC. IN ENGIN. & SCIEN.	TOTAL
St. John's Biological	358	455	7	-	-	820
St. John's Technological	75	7	-	-	-	82
Halifax	646	41	17	-	-	704
Grande Riviere	108	9	-	-	-	117
Dartmouth	121	30	-	-	-	151
St. Andrews	981	237	10	-	-	1,220
Ste. Anne de Bellevue	603	143	6	-	-	752
Winnipeg	357	78	9	-	-	444
Vancouver	352	40	8	-	-	400
Nanaimo	1,605	745	15	-	-	2,365
Grants	-	-	-	44	-	44
Scholarships	-	-	-	-	28	28
Office of the Chairman	108	28	4	-	-	140
Office of the Editor	-	-	129	-	-	129
GRAND TOTAL	5,314	1,813	205	44	28	7,404

FISHERIES RESEARCH BOARD OF CANADA
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APPENDIX XX

Expenditures Associated with Scientific Activities BY FUNCTIONS
1965-66 (Operating & Capital expressed in thousands of dollars)

STATION	INTRAMURAL R&D	DATA COLLECTION	SCIENTIFIC INFORMATION	SUPPORT OF R&D IN UNIVERSITIES	SUPPORT OF HIGHER EDUC. IN ENGIN. & SCIEN.	TOTAL
St. John's Biological	389	509	7	-	-	905
St. John's Technological	127	8	-	-	-	135
Halifax	835	14	16	-	-	865
Grande Riviere	122	12	-	-	-	134
Dartmouth	258	58	-	-	-	316
St. Andrews	971	1,013	11	-	-	1,995
Ste. Anne de Bellevue	307	70	8	-	-	385
Winnipeg	417	85	9	-	-	511
Vancouver	415	22	11	-	-	448
Nanaimo	1,772	1,053	19	-	-	2,844
Grants	-	-	-	54	-	54
Scholarships	-	-	-	-	25	25
Office of the Chairman	162	45	4	-	-	211
Office of the Editor	-	-	174	-	-	174
GRAND TOTAL	5,775	2,889	259	54	25	9,002

FISHERIES RESEARCH BOARD OF CANADA
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APPENDIX XXI

Expenditures Associated with Scientific Activities BY FUNCTIONS
1966-67 (Operating & Capital expressed in thousands of dollars)

STATION	INTRAMURAL R&D	DATA COLLECTION	SCIENTIFIC INFORMATION	SUPPORT OF R&D IN UNIVERSITIES	SUPPORT OF HIGHER EDUC. IN ENGIN. & SCIEN.	TOTAL
St. John's Biological	400	654	9	-	-	1,063
St. John's Technological	97	8	-	-	-	105
Halifax	1,000	38	24	-	-	1,062
Grande Riviere	150	3	-	-	-	153
Dartmouth	433	129	13	-	-	575
St. Andrews	1,047	971	18	-	-	2,036
Ste. Anne de Bellevue	307	111	11	-	-	429
Winnipeg	846	170	27	-	-	1,043
Vancouver	1,036	21	13	-	-	1,070
Nanaimo	1,884	1,363	19	-	-	3,266
Grants	-	-	-	250	-	250
Scholarships	-	-	-	-	9	9
Office of the Chairman	219	77	13	-	-	309
Office of the Editor	-	-	181	-	-	181
GRAND TOTAL	7,419	3,545	328	250	9	11,551

FISHERIES RESEARCH BOARD OF CANADA
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APPENDIX XXII

Expenditures Associated with Scientific Activities BY FUNCTIONS
1967-68 (Operating & Capital expressed in thousands of dollars)

STATION	INTRAMURAL R&D	DATA COLLECTION	SCIENTIFIC INFORMATION	SUPPORT OF R&D IN UNIVERSITIES	SUPPORT OF HIGHER EDUC. IN ENGIN. & SCIEN.	TOTAL
St. John's Biological	535	735	11	-	-	1,281
St. John's Technological	79	15	-	-	-	94
Halifax	1,301	50	28	-	-	1,379
Grande Riviere	142	20	-	-	-	162
Dartmouth	648	651	16	-	-	1,315
St. Andrews	1,187	920	23	-	-	2,130
Ste. Anne de Bellevue	429	205	10	-	-	644
Winnipeg	1,343	100	66	-	-	1,509
Vancouver	1,135	35	17	-	-	1,187
Nanaimo	2,035	1,604	35	-	-	3,674
Grants	-	-	-	400	-	400
Scholarships	-	-	-	-	7	7
Office of the Chairman	250	100	37	-	-	387
Office of the Editor	-	-	337	-	-	337
GRAND TOTAL	9,084	4,435	580	400	7	14,506

FISHERIES RESEARCH BOARD OF CANADA
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APPENDIX XXIII

Expenditures associated with scientific activities BY SCIENTIFIC DISCIPLINE
(operating and equipment costs in thousands of dollars)

		1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	%	1968-69 (Estimated)
1	Engineering and Technology	375	395	445	509	638	787	7	835
2d	Biological Sciences	3,190	3,315	3,750	4,292	5,374	6,670	59	7,020
2e	Chemistry including Biochem.	1,250	1,290	1,460	1,673	2,095	2,640	23	2,730
2h	Ocean-ography	590	623	700	800	1,002	1,254	11	1,310
	TOTALS	5,405	5,623	6,355	7,274	9,109	11,351	100	11,895

FISHERIES RESEARCH BOARD OF CANADA
OTTAWA,
September 9, 1968

APPENDIX XXIV

Expenditures by Fiscal Years
(OPERATING & CAPITAL in thousands of Dollars)

STATION	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69 (Estimated)
St. John's Bio.	721	762	820	905	1,063	1,281	1,378
St. John's Tech.	74	73	82	135	105	94	133
Halifax	446	596	704	865	1,062	1,379	1,070
Grande-Riviere	113	122	117	134	153	162	169
Dartmouth	127	147	151	316	575	1,315	1,139
St. Andrews	916	1,052	1,228	1,995	2,036	2,130	2,024
Ste. Anne de Bellevue	330	290	752	385	429	644	757
Winnipeg (London)	362	370	444	511	1,043	1,509	2,065
Vancouver	330	337	400	448	1,070	1,187	1,060
Nanaimo	3,258	2,264	2,365	2,844	3,266	3,674	5,030
Grants & Scholar.	48	50	72	79	259	407	500
HQ incl. Public.	219	228	269	385	490	724	810
TOTALS	6,944	6,291	7,404	9,002	11,551	14,506	16,135

FISHERIES RESEARCH BOARD OF CANADA
OTTAWA,
September 9, 1968

APPENDIX XXV

Regional average expenditures (Operating and Capital)
in the period 1962-63 to 1968-69

REGION	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69 (estimated)	AVERAGE* % DISTRIBUTION
Atlantic Coast	2,397	2,752	3,102	4,350	4,994	6,361	5,913	43.0
Central-Arctic	692	660	1,196	896	1,472	2,153	2,822	12.7
Pacific Coast	3,588	2,601	2,765	3,292	4,336	4,861	6,090	38.5
Headquarters	267	278	341	464	749	1,131	1,310	5.8
TOTAL	6,944	6,291	7,404	9,002	11,551	14,506	16,135	100.0

* excluding 1968-69

APPENDIX XXVI

Expenditures on educational leave

Year	Expenditure *	No. of employees
1962-63	$ 7,900	2
1963-64	7,150	2
1964-65	20,050	4
1965-66	11,400	3
1966-67	28,125	5
1967-68	37,310	5
1968-69	33,100	5

* Expenditure involved in taking local courses is not available.

APPENDIX XXVII

Summary of Research Contracts by Fiscal Years

Year	Contractor	Purpose	Amount
1962-63	University of British Columbia	Nutritive value of fish meals	$ 6,399:00
	University of New Brunswick	Effects of DDT spray on Atlantic Salmon	4,500:00
	B. T. Khouw	Research on flagellate protozoans Hexamita	400:00
	University of Manitoba	Effects of sudden thermal shock on freshwater fish	1,600:00
	Great Lakes Institute University of Toronto	Support of limnological program	10,000:00
			22,899:00
1963-64	University of New Brunswick	Effects of DDT spray on salmon	1,000:00
	B. T. Khouw	Continuation of 62-63 contract	2,300:00
	University of Manitoba	Effects of thermal shock on fish	1,000:00
	University of British Columbia	Nutritive value studies	6,311:00
	B.J. Myers	Parasitology of Arctic Char	1,500:00
	Carleton University	Study on Atlantic Salmon	1,250:00
	Mohamed A. Ali, University of Montreal	Photobehaviour in salmon	2,000:00
			15,361:00
1964-65	B. T. Khouw	Research on flagellate protozoans	500:00
	Carleton University	Study on Atlantic Salmon	3,250:00
	M. A. Ali	Completion of 63-64 contract	600:00

Year	Contractor	Purpose	Amount
1964-65 (Cont'd)			
	Great Lakes Institute	Support of Limnological program	$ 10,000:00
	University of British Columbia	Study of fish stocks in North Pacific	10,000:00
	University of British Columbia	Studies on herring meal	5,399:00
	University of British Columbia	Studies on reproductive morphology of fur seal	7,000:00
	Dr. I. A. McLaren	Study on ringed seal	1,000:00
	Dr. V. D. Vladykov	Studies on sea lamprey	3,500:00
	University of Toronto	Studies on lantern fishes of Atlantic Coast	2,500:00
	University of Manitoba	Effects of thermal shock on freshwater fish	200:00
			43,949:00
1965-66	Carleton University	Effects of DDT on salmon	4,500:00
	University of British Columbia	Nutritive qualities of freshwater fish meal	1,500:00
	University of British Columbia	Study of fish stocks of North Pacific	2,000:00
	University of British Columbia	Study on Harbour Seals	5,000:00
			13,000:00
1966-67	University of Toronto	Revisions of Bulletins Fishes of Atlantic Coast	3,000:00
	University of Toronto	Literature survey nutritive value fishery products	24,000:00
	B.C. Research Council	In-cannery colour sorting	20,000:00
			$ 47,000:00

Contractor	Purpose	1967-68	1968-69
University of Toronto	To investigate groups of fishes of the Atlantic Coast	$ 3,000:00	$ 6,000:00
University of British Columbia	To reorganize and update FRB Bulletin #68 - Fishes of the Pacific Coast of Canada	10,000:00	15,000:00
University of Toronto	To analysis of tag and recovery data - Heming Lake (Population Dynamics)	8,000:00	2,000:00
University of Toronto	Preparation of Manuscript on Freshwater Fishes of Canada	23,000:00	12,000:00
B.C. Research Council	To develop instrumentation for in-cannery sorting of salmon	20,000:00	20,000:00
University of Toronto	To provide information on nutritive values of Canadian Fishery Products for incorporation into FRB bulletin	10,000:00	10,000:00
University of Toronto	To study fish populations	-	9,300:00
University of British Columbia	To evaluate nutritive values of various fish meals and other fish products	15,000:00	15,000:00
		$ 89,000:00	$ 79,300:00

APPENDIX XXVIII

Report on inventions received by Canadian Patents and Development Ltd.
from the Fisheries Research Board to March 31, 1968

Case Number	Title	Inventors	Status of Invention	Income	Award
1671	Fish Washing Machine	W.A. MacCallum	Canadian Patent No. 563, 417 Licensed to: Atkinson & Bower Atlantic Bridge Co. Ltd. Hawbolt Gas Engines	$ 20.00	$ 3.00
1721	Method of Producing Block Ice	H.L.A. Tarr D.C. Gillespie	Canadian Patent No. 552, 878		
1828	Mid-water Fishing Trawl for Herring and the like	W.W. Johnson W.E. Barraclough D.G. Moore	Canadian Patent No. 608, 969		
2554	Aluminum Dual-Purpose Mid-water Bottom Otterboard	W.W. Johnson W.E. Barraclough	Canadian Patent No. 612, 992 U.S. Patent No. 2, 942, 371		
3255	Improved Mid-water Trawl	W.W. Johnson	Canadian Patent No. 776, 376 U.S. Patent No. 3, 316, 670		
3404*	Air-lift Pump for Fish	J.S.M. Harrison S.W. Roach F.G. Claggett	Patent Application pending in U.S.A.		
3405*	Hydraulic Elevator for Fish	J.S.M. Harrison S.W. Roach F.G. Claggett	Canadian Patent No. 756, 959 U.S. Patent No. 3, 254, 924		
4223	Ultrasonic Fish Quality Tester	M. Freese D. Makow	Under assessment		
*	CASES 3404 and 3405 LICENSED TO:	J. H. Todd and Sons Ltd.		$ 500.00	$ 75.00

APPENDIX XXIX

Number of scientific articles produced by Fisheries Research Board scientists and/or published by FRB

A. JOURNAL OF THE FISHERIES RESEARCH BOARD

YEAR	FRB SCIENTISTS	OTHER SCIENTISTS	NUMBER OF ARTICLES	NUMBER OF PAGES
1962	54	26	80	1185
1963	78	27	105	1566
1964	92	36	128	1569
1965	84	48	132	1615
1966	97	77	174	2039
1967	103	102	205	2707

B. BULLETINS OF THE FISHERIES RESEARCH BOARD (mostly by FRB scientists)

YEAR	NUMBER OF ISSUES	NUMBER OF PAGES
1962	5	492
1963	5	323
1964	7	389
1965	6	718
1966	7	1231
1967	11	1102

C. PAPERS BY FRB SCIENTISTS IN NON-BOARD PUBLICATIONS

YEAR	NUMBER OF ARTICLES	NUMBER OF PAGES
1962	87	705
1963	85	1088
1964	67	880
1965	57	892
1966	125	970
1967	82*	1071

* Not including 75 interpretive papers totalling 312 pages.

APPENDIX XXX

FRB employees who had opportunity to train themselves in specialized fields while employed with FRB and subsequently left and made important contributions to their field elsewhere.*

General Field of Contribution	Number of Individuals
Department of Fisheries	5
Other Federal Agencies	4
External Aid (incl. Colombo Plan)	7
Provincial governments	3
Provincial Research Council	2
Canadian universities	9
United States universities	3
United Nations - FAO	9
- UNESCO	1
Other International Fishery Agencies	3
Other fields	2
TOTAL	48

* Also includes number of persons who returned to FRB Service.

APPENDIX XXXI

Research teams established during the period 1962 to 1967

(1) FRB Laboratories

(a) St. John's Station

- A team investigating freezing applications in the operation of commercial fishes has been most productive.

- A special group has been established to concentrate attention on the rapidly developing herring fishery off Newfoundland.

(b) Marine Ecology Laboratory

- A team specially oriented to study of the processes underlying marine production (work underway but still recruiting).

(c) Halifax Station

- A team with special competence in disease research. Major contributions have already been made in clarifying some of the problems of the shellfish industry.

- A team effort in isolating natural products from marine organisms (hormones, marine oils, etc.) has gained international recognition for its contributions.

(d) St. Andrews Biological Station

- A team approach has been adopted to conduct fundamental research on fish behaviour for the purpose of establishing a sound biological base for improvements in gear efficiency (still in the recruiting stage).

(e) Freshwater Institute

- A multidiscipline research team to tackle the biological aspects of pollution (eutrophication) in the Great Lakes and other freshwater sources (still in organization stage).

- A team made up of biochemists, engineers, microbiologists, physicists to attack technological problems faced by the freshwater fisheries in processing and utilizing their catch.

(f) Vancouver Station

- A new team of scientists trained and equipped to investigate the complex problem of fish flavours.

- A team working closely with scientists at UBC was established to investigate phytoplankton.

(g) Nanaimo Station

- A team effort did much during the early 1960's to determine the racial origins of salmon stocks on the high seas.

- A research team approach involving physical and biological oceanographers and fishery specialists is being employed in the Strait of Georgia to obtain a greater appreciation of factors influencing fishery production.

2. <u>Universities</u>

(a) <u>University of Toronto</u>

- A team of human nutritionists in the Faculty of Food Science has become the leading authority on the use of marine products in human diets as a result of FRB contract support.

(b) <u>University of British Columbia</u>

- A team of poultry nutritionists became established authorities on the use of marine and freshwater products in animal feeds as a result of FRB contract support.

First Session—Twenty-eighth Parliament

1968

THE SENATE OF CANADA

PROCEEDINGS

OF THE

SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*

The Honourable DONALD CAMERON, *Vice-Chairman*

No. 18

WEDNESDAY, DECEMBER 18th, 1968

WITNESSES:

Department of Transport: D. M. Ripley, Director, Marine Hydraulics Branch; E. L. Hewson, Director, Transportation Policy and Research Branch; H. J. Williamson, Director, Telecommunications and Electronics Branch; Dr. D. P. McIntyre, Chief, Research and Training Division, Meteorological Branch; and A. L. Peel, Chief, Railway and Highway Economics Division, Transportation Policy and Research Branch.

APPENDIX:

19.—Brief submitted by the Department of Transport.

The Queen's Printer. Ottawa. 1969

29615—1

MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird	Hays	O'Leary (*Carleton*)
Bélisle	Kinnear	Phillips (*Prince*)
Bourget	Lamontagne	Robichaud
Cameron	Lang	Sullivan
Desruisseaux	Leonard	Thompson
Grosart	MacKenzie	Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

29615—1½

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

WEDNESDAY, December 18th, 1968.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 10.00 a.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Aird, Bourget, Cameron, Grosart, Kinnear, Lang and Robichaud. (8)

Present but not of the Committee: The Honourable Senator McGrand.

In attendance: Philip Pocock, Director of Research (Physical Science).

The following witnesses were heard:

DEPARTMENT OF TRANSPORT:

D. M. Ripley, Director, Marine Hydraulics Branch;

E. L. Hewson, Director, Transportation Policy and Research Branch;

H. J. Williamson, Director, Telecommunications and Electronics Branch;

Dr. D. P. McIntyre, Chief, Research and Training Division, Meteorological Branch; and

A. L. Peel, Chief, Railway and Highway Economics Division, Transportation Policy and Research Branch.

(*A curriculum vitae of each witness follows these Minutes.*)

The following is printed as Appendix No. 19: Brief submitted by the Department of Transport.

At 12.55 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Ripley, D. M., age: 50 years; Affiliation: Department of Transport, Marine Hydraulics Branch; Position: Branch Director; Education: B.Sc.—Queen's University, 1950; Professional Status: Member, Association of Professional Engineers of Ontario; Experience: 1939-1945, Canadian Armed Forces. 1950-1951, Department of Transport, Hydraulic Engineer with the Special Projects Branch, Ottawa, engaged in preliminary Seaway design. 1952-1959, St. Lawrence Seaway Authority—Senior Assistant Engineer (Hydraulics) employed on design and construction of the Seaway. During this period was responsible for hydraulic model studies and water use studies. 1960-1964, Department of Transport. Chief Special Projects Division. Responsible for departmental water-use studies. 1965-1968, Department of Transport. Director, Marine Hydraulics Branch. Branch is composed of three divisions: Hydraulics Studies, St. Lawrence Ship Channel and Marine Traffic Control. Continued responsibility relative to water-use interests of the Department. Boards and Committees: Since 1959—Member and Vice Chairman of the Canadian Section of the International St. Lawrence River Board of Control, a Board established to ensure compliance with the IJC Orders of Approval for the St. Lawrence River International Power Development. 1952-1967—Member of the Canada-U.S. Coordinating Committee on Great Lakes—St. Lawrence River Hydraulic Data. Many ad hoc committees dealing with water use projects, hydraulic engineering and related research.

Hewson, Edward Lorne. Address: 655 Brierwood Avenue, Ottawa 3, Ontario. Marital Status: Married. Children: Two boys. Citizenship: Canadian. Age: 44. Education: B.A., Mathematics & Physics, University of B.C., 1948. Business Admin., CN Staff Training Course. Bishops University, 1954. Military Service: 1943-1945 RCNVR—Radar & Wireless Tech. RA 4; Career: 1941-42, Radio Operator, Edmonton, Alta., Yellowknife, N.W.T. Fort Smith, N.W.T., Canadian Pacific Airlines; 1943-48, (During leave and vacation) Telegraph Operator—Canadian National Railways; 1948-52, Train Dispatcher—Can. National Railways, Kamloops, B.C., Smithers, B.C., The Pas, Manitoba, Vancouver, B.C., Winnipeg, Manitoba; 1952-54, Chief Train Dispatcher, Smithers, B.C., Edson, Alta., Kamloops, B.C.; 1954-56, Asst. Superintendent, Smithers, B.C.; 1956-57, Research Engineer, Dept. of Research and Development, Montreal, P.Q.; 1957-60, Division Superintendent, Operating Dept., Edson, Alta. and The Pas, Manitoba; 1960-60, Supervisor, Mount Royal Tunnel Service Project, Office of Chairman and President, Montreal, P.Q.; 1960-62, Chief of Budgets and Statistics, Department of Accounting and Finance, Montreal, P.Q.; 1962-64, Operation Officer, Department of Transportation and Maintenance, Montreal, P.Q.; 1964-68, General Supt. Transportation, Atlantic Region, C.N.R., Moncton, N.B.; Feb. 1/68, Director, Transportation Policy and Research Branch, Department of Transport, Ottawa; Research Papers or Major Projects: 1. The Economics of Railway Signalling Part II—1956—(committee report)—Development of methodology and detailed application to fifty mainline subdivisions of C.N.R.—adopted as a program by Board of Directors. 2. Abandonment of the Harte Subdivision—1957—an economic appraisal of the merits

of retiring the second main line between Winnipeg and Portage la Prairie. 3. The Mount Royal Tunnel Service Project—1960—an economic appraisal of the merits of converting the Montreal tunnel commuter line to rapid transit. 4. Responsibility Budgets and Accounting—1961—in conjunction with Price Waterhouse and Co.—a project to develop and implement charts of accounts and budgets on a geographic and functional basis to establish accountability and responsibility of senior management line and staff officers for railway operating expenses. 5. Improved Freight Car Distribution—1962-63—a project to increase availability of freight cars in response to Russian and Asiatic grain orders. Developed standardized freight car classifications, inventory control and reporting system based upon current forecasting and auditing techniques using manual methods. 6. Mechanized Freight Car Distribution—1966-67—application of computer techniques and improved communications facilities to freight car distribution. Pilot Project—Atlantic Region C.N.R. 7. Centralized Operations Control—1967-68—a pilot project to carry out the functions of freight car distribution, passenger car distribution, crew, locomotive and caboose assignment, train dispatching, car tracing, supervision of local placement and switching of cars from one centre in the Maritimes. Professional Associations: Canadian Transportation Research Forum, Canadian Railway Club. Interdepartmental Committees: Air Cushion Vehicle Committee, Chairman; Air Statistics Committee; Northumberland Strait Crossing Committee, Chairman; Air Canada Winnipeg Base Working Party, Chairman; Containerization Committee; Roads and Highway Policy Committee; International Bridges Committee.

Williams, Harold J. P. Eng. Born: Regina, Sask. July 17, 1909; Office Address: A/Director, Telecommunications & Electronics Branch, Room 2157—#3 Building; Marital status; Married. Three children; Citizenship: Canadian; Primary Education: Regina & Saint John N.B. Public Schools; University: University of New Brunswick B. Sc in Electrical Engineering 1930; Additional Education: National Defence College 1949–1950; Awards: Beaverbrook Scholar to UNB; Coronation Medal; Professional Associations: Member, Association of Professional Engineers of Ontario; Engineering Institute of Canada; Institute of Public Administration of Canada; Flying Activity: Holder of a Private Pilot (multi-engine endorsement) License; Positions Held: 1930–1931, Design Engineer, Northern Electric Co., Montreal; Design of rubber insulated wires and cables; 1931–1932, Junior Engineer, Dept. of National Defence; Royal Canadian corps of Signals, Ottawa and Regina; Installation and Operation of Airway Radio Beacon System; 1932–1936, Unable obtain Technical or Professional employment; 1936–1937, Broadcasting station technician, Radio Station C.F.N.B., Fredericton, N.B.; 1937–1939, Junior Engineer, Radio Branch, Dept. of Transport; Installation Radio Range equipment, Western Canada; 1939–1941, District Radio Aids Engineer, Dept. of Transport, Toronto; Responsible for supervision of Installation, Maintenance and Operations of Radio Aids and associated Telecommunications facilities; Administration of Radio Operators, Technicians and Engineers, for Ontario, East of Nakina; 1941–1949, District Radio Aids Engineer, Dept. of Transport, Edmonton; Responsibilities as above with particular emphasis on co-ordination with Canadian & U.S. Military & Alaskan Civil Authorities for all Canadian civil telecommunication facilities in Alberta, North Eastern British Columbia, Yukon and N.W.T. MacKenzie River areas; 1949–1950, Attended National

Defence College as first representative to this course from Telecommunications Branch, Dept. of Transport; 1950–1954, Regional Director, Air Services, Moncton, N.B.; Responsible for direction of all Branches of Air Services in area of N.B., P.E.I., N.S. and Nfld. for Civil Aviation, Meteorological, Airport Construction and Telecommunications; 1954–1961, Regional Director, Air Services, Edmonton, Alta.; Responsibilities similar to above for Alberta, North Eastern B.C., Yukon, N.W.T. including Arctic Islands including and west of Cambridge Bay; 1961–1967, Chief of Technical & Policy Co-ordination of Telecommunications & Electronics Branch, Dept. of Transport, Ottawa; Responsible for co-ordination of all technical and policy matters on Telecommunications, within Dept. and with other departments as required; Representative for Dept. and Canada to International and Commonwealth Telecommunications Conferences, international negotiations and Technical discussions on Satellite Ground Stations for Nimbus and Intelsat programs. Responsible for supervision of Research Development and Programming Section of Branch; 1967–Present, Acting Director, Telecommunications & Electronics Branch Air Services Dept. of Transport, Ottawa; Directs all activities related to Telecommunications and Electronics programs to provide services and facilities for Aviation, Marine and Meteorological services in keeping with policies and budgetary constraints of the Department.

McIntyre, Donald P. Address: 147 Davenport Rd., Toronto 5, Ontario. Marital Status: Married. Citizenship: Canadian. Education: B.A., Honours Mathematics and Physics (Pure Mathematics Division), University of Toronto, 1938. M.A., Physics (Meteorology), University of Toronto, 1939. Ph.D., Meteorology, University of Chicago, 1949. Leonard Scholarship, University of Toronto; James Harris Scholarship in Mathematics, University of Toronto; Graduate Fellowship in Meteorology, University of Chicago. Career (Meteorological Service of Canada): 1939-1947, Forecaster (Officer-in-Charge at some locations) Toronto, Ont.; Vancouver, B.C.; Victoria, B.C. (RCAF No. 2 Group H.Q.); Prince George, B.C ; Whitehorse, Yukon; Montreal, Que.; 1947-1959, (University of Chicago); 1949-1950, Research Meteorologist, Research & Training Division, Toronto; 1950, Chief, Research and Training Division, Toronto; Note: The Research and Training Division is largely responsible for: 1. Research into the physics and behaviour of the atmosphere; 2. Consultation services based on research, e.g. air pollution; 3. Development of new observing and prediction systems; 4. Professional and technical training; 5. Extended range forecasting; 6. Hemispheric, computer based, current and predicted charts in support of Forecast Services; Research Awards: Darton First Prize (Canadian) of Royal Meteorological Society (twice); Scientific Societies: Canadian Meteorological Society (formerly Canadian Branch, Royal Met. Soc.) 1953-55 President; Royal Meteorological Society (London): 1952, Fellow; 1955-57, Vice-President for Canada; 1956-64, On Scientific Activities Fund Committee. American Meteorological Society (Boston): 1946, Professional member; 1959-62, Member of Council; 1961-66, Editor, Journal of Applied Meteorology; 1961-66, Member of Publications Commission; 1968, Nominated to run for President. New York Academy of Science (New York): 1965, Active Member. Special Activities: 1949-63, Special lecturer, Department of Physics, Graduate School, University of Toronto; 1952-53, Arrangements Committee, Joint Roy. Met. Soc.-American Met. Soc. Conference, Toronto; 1957-58, Arrangements Committee, Scandinavian-American Meteorological Conference, Bergen; 1959, Distinguished Lec-

turer, Texas A&M University Summer Teachers School; 1966, Member of official Canadian delegation, consisting of 10 scientists, to the 11th Pacific Science Congress, Tokyo. Posts: International or Foreign: 1953, Representative for Canada, Commission for Atmospheric Sciences, World Meteorological Organization (a U.N. specialized agency); 1961-65, Chairman, Working Group on International Projects in Meteorology (WMO); 1965, Canadian representative, Experimental Inter-American Meteorological Rocket Network (EXAMET NET); 1965, Member, Standing Committee on Meteorology Pacific Science Association. Posts: Canadian: 1949-63, Special Lecturer, Graduate School, Dept. of Physics, University of Toronto; 1961, Member, NRC Associate Committee on Space Research (ACSR) (National Committee for COSPAR, Committee on Space Research, International Council of Scientific Unions); 1961-67, Member NRC Associate Committee on Geodesy and Geophysics (ACGG) (National Committee for International Union of Geodesy and Geophysics); 1961-67, Member, NRC Subcommitee on Meteorology and Atmospheric Sciences (SOMAS) (National Committee for International Association of Meteorology and Atmospheric Physics); 1967, Advisor to NRC Subcommittee on Meteorology and Atmospheric Sciences (SOMAS); 1962-68, Member of Canadian Committee for IQSY, International Quiet Sun Years, and reporter for meteorology; 1968, Department of Transport representative on the Inter-departmental Appraisal Committees on Research Scientists and Research Management (IAC). Publications: In the following: American Mathematical Monthly, U.S.A.; Journal of Meteorology, the American Meteorological Society, U.S.A.; Bulletin of the American Meteorological Society, U.S.A.; Encyclopedia of Physics (the article —Meteorology), U.S.A.; Quarterly Journal of the Royal Meteorological Society, U.K.; Publication of the Royal Meteorological Society, Canadian Branch, Canada; Physics in Canada, Canada; Archiv fur Meteorologie, Geophysik und Bioklimatologie, Austria; Geophysica, Finland.

Peel, Alexander Leonard; Address: 46 Carbrooke Road, Glen Cairn, Ontario; Marital Status: Married; Children: two girls; Citizenship: Canadian; Age: 33; Education: A. University: 1. University of California, Berkeley, California; (a) Degree: Master of Business Administration, September 1967: (b) Thesis: A Regulatory Structure for Canadian Motor Carriers; (c) Scholarships: None. 2. University of British Columbia, Vancouver, British Columbia; (a) Degree: Bachelor of Commerce, June 1959; (b) Thesis: Meteorological Phenomena and Their Effect on Airline Route Cost; (c) Scholarships: Elmer Johnson Memorial Scholarship. B. Advanced Work and Special Training: 1. Economic Theory Courses—University of Ottawa; 2. Department of Transport Management Seminar; 3. I.B.M. Data Processing Courses. C. Research Papers: 1. The Economic Regulation for Motor Carriers May 1968; 2. The Use of Non-Quantifiable Variables in Decision Making October 1968. Military Service: (a) Pilot, University Reserve Training Plan, R.C.A.F., 1953-57; (b) Air Cadet Officer, 1957-62. Work Experience: A. Department of Transport, Ottawa, from: March 1965 to present; Position: 1. Chief Economist, Railway and Highway Division, Transportation Policy and Research Branch. From: March 1968 to present; 2. Highway Economist, Railway and Highway Division, Transportation Policy and Research Branch. From: March 1965 to March 1968. B. Employer: Pacific Intermountain Express, Inc., Oakland, California. From: November 1962 to March 1965. Position: Superintendent of Budgets and Cost Control, Department of Research and Development. C. Employer: Canadian National Railways, Montreal, Quebec.

From: June 1959 to November 1962. Position: 1. Assistant Research Economist, Department of Research and Development. From: April 1962 to November 1962; 2. Assistant Economist, Department of Research and Development. From: April 1960 to April 1962; 3. Trainee Economist, Department of Research and Development. From: June 1959 to April 1960. Professional Associations: A. Canadian Transportation Research Forum. Membership in Interdepartmental Committees: 1. Interdepartmental Committee on Northumberland Strait Crossing, Chairman. 2. Interdepartmental Committee on Bridge Policy, Chairman. 3. Road and Highway Policy Committee. 4. Mainland-Newfoundland Transportation Committee.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Wednesday, December 18, 1968

The Special Committee on Science Policy met this day at 10.00 a.m.

Senator Maurice Lamontagne (Chairman) in the Chair.

The Chairman: Honourable Senators, this morning we will be considering the brief which has been presented to us by the Department of Transport. As you will have noticed, this brief is divided into four quite different parts. I propose that we should consider the whole brief together when we come to the general discussion.

By order we will deal first with the Marine Hydraulics Branch; then the Metereological Branch; thirdly, Transportation Policy and Research Branch; and finally Telecommunications and Electronics Branch.

We have with us this morning the four directors of these branches: to my immediate right is Mr. Hewson, Director of Transportation Policy and Research Branch; to my extreme right is Dr. McIntyre, Chief of Research and Training Division in the Metereological Branch; to my immediate left is Mr. Williamson, Director of the Telecommunications and Electronics Branch, and to my extreme left is Mr. Ripley, Director of the Marime Hydraulics Branch.

They will all give us a short opening statement. We will start with the Marine Hydraulics Branch, then Transportation Policy and Research Branch, Telecommunications and Electronics Branch, and finally the Meteorological Branch, which will also present to us some slides, which I am told are very interesting.

Mr. D. M. Ripley, Director, Marine Hydraulics Branch Department of Transport: Mr. Chairman, honourable senators, in response to your earlier request a brief was presented by the Marine Hydraulics Branch of the Department of Transport. Now with your permission I should like to summarize the earlier statements, perhaps in an attempt to highlight the more significant points.

The activities of the Marine Hydraulics Branch of interest to your committee fall within the definition of applied research and development and data collection. That is to say the Marine Hydraulics Branch is involved in research with specific practical applications in view. The objectives of the Branch relate to navigation requirements in waterways where the Department of Transport has responsibilities. In consequence, the research activities have reference to water resource management, navigation channel design, behaviour of ships in confined waterways, sediment transport and ice phenomena.

In recent years emphasis has been placed on the navigation requirements in the St. Lawrence and Saguenay River ship channels and to a certain extent in the Great Lakes system. The organization of the Branch reflects its operating and maintenance functions and the associated research and development activities. The organization chart may be found on page 8 of the DOT brief and it may be seen there that in respect to research and development there is a Hydraulics Studies Division which can be seen on the right hand side of the chart which appears on page 8.

Also within the St. Lawrence Ship Channel Division at Montreal, which incidentally is part of the Marine Hydraulics Branch organization, there is an engineering field investigation section. This is illustrated in the chart on page 10 of the brief.

The Hydraulics Studies Division provides the hydraulics engineering capability and related technical support for the total Marine Services programme. It is a small group of specialists, actually ten in number. It provides the focal point within the department in hydraulic engineering research for input to

planning for the ordinary development of said marine transportation. It is intended that this group should not be substantially enlarged in the future and that the policy of seeking outside assistance on special work should be followed. In accordance with this policy, contracts have been arranged with commercial laboratories for some hydraulic studies. The National Research Council have been invited to undertake similar studies on behalf of the department. In fact, the National Research Council is presently engaged in a large-scale comprehensive hydraulic model study initiated by the Department of Transport.

The Hydraulic Studies Division has also several research tasks assigned to it in connection with the International Joint Commission Water Resource Management Studies in the Great Lakes, St. Lawrence River Basin. It is also involved in research of ice phenomena as they may affect navigation during the winter. The average annual expenditures of the division are about $500,000.

Turning now to the activities of the field investigation section at Montreal, it may be said that this is the primary source of the basic data for planning of projects, the control of projects, and for the input to the overall research and development programmes, for example the model studies activities.

The annual expenditures of this field investigation group have been of the order of $800,000. It has a staff of 70, of which seven are professional engineers.

It may be noted that the data collection activities are associated with hydrography, soils analyses and the observations related to river ice conditions.

In the field investigation section of the Ship Channel Division the policy is to employ specialized consultants on short term projects requiring a particular expertise.

Now, to summarize the activities of the Marine Hydraulics Branch that would seem to have relevancy at this inquiry it may be considered to be in the field of applied research and development and the data collection. These activities are related to the planning process, the determination of project feasibility and the co-ordination of the total effort of the department and associated interests in the development of navigation channels.

Thank you, Mr. Chairman.

The Chairman: Thank you, Mr. Ripley; now we go to Mr. Hewson.

Mr. E. L. Hewson, Director, Transportation Policy and Research Branch, Department of Transport: Mr. Chairman and honourable senators: may I say that I am honoured to have the opportunity to appear today before your Committee on Science Policy.

The Transportation Policy and Research Branch functions largely as a staff unit for the Deputy Minister and the Minister of Transport, carrying out economic appraisals and studies of various types, rendering assistance in the implementation of programmes, co-ordinating departmental activities for inter-departmental committees and supplying or arranging for the supply of a wide variety of information needs pertaining to policy and planning decisions.

In addition, the Branch performs a direct liaison role in the development of long and short term operating and financial plans of the Canadian National Railways and Air Canada, with some lesser responsibilities in respect of other agencies and Crown corporations reporting to the Minister.

The Department of Transport is large and complex. My direct involvement has been for a period of less than one year; consequently my comments are related principally to current activities.

We have four divisions and will shortly have a fifth division carrying out applied or developmental research within the limitations set by priorities and resources.

The Air Economics Division is heavily involved in the design and planning of the new airports for Montreal and Toronto. Our contribution consists of funding and sharing the supervision of contract research and development being done by consultants, in providing independent forecasts of passenger and freight volumes, in examining methodology, checking assumptions and testing alternatives and in devising suitable methods of transferring future airport costs to the users.

Next in importance has been the economic assessment of Air Canada's very rapidly expanding fleet and facilities requirements. A good deal of time has been spent seeking a solution to Air Canada's Winnipeg overhaul base problem. A survey and forecast of general aviation and airport activity at individual airports is nearing completion.

We have been carrying out a series of benefit-cost studies related to requests for federal government assistance in the construction of landing strips under the small airports programme.

Finally, the division in co-operation with counsel scrutinizes and advises upon appeals to the Minister from decisions of the Air Transport Committee relating to the licensing of air carriers.

The Railway and Highway Economics Division contributed substantially to the drafting of the National Transportation Act. Within the past year the economic assessment and development of alternatives to the proposed P.E.I. Causeway has been a major effort. Forecasts were extended as far as the year 2030 and exploration of alternatives included investigation of such things as large sized hovercraft.

A study is nearing completion on the economic feasibility of extending the season of the Port of Churchill, Manitoba. A large research contract has been let to examine economic resources and market potential which might be tapped by constructing a railway connecting the trans-continental rail line from northern British Columbia through the Yukon to the Alaskan border. A corresponding route location study was entered into on a joint funding basis with CNR earlier this year.

Work is underway to develop a system model for transportation from the mainland to Newfoundland in order to assess the optimum mix of traffic between water carriers, rail and trucks, to assist the government in investment and subsidy decisions.

We have been working co-operatively with the Department of Forestry and Rural Development in supplying the transportation input for regional development plans.

Finally, preparatory work and investigation has been underway in anticipation of federal regulation of highway transport to follow the proclamation of Part III of The National Transportation Act.

As an extension of the work carried out in the railway and highway fields the Minister recently announced the establishment of the Urban Transportation Division. At this point in time only the chief of the division has been appointed and we are in the process of staffing.

A small brief dealing with urban transportation was prepared and presented to the Task Force on Housing and Urban Development, to outline a proposed programme. To date, one research contract has been let for a study to assess within fairly broad limits the relationship or urban transportation efficiency to gross national product, to assess relative efficiencies in major urban areas of Canada and, thus, to provide at least order of magnitude predictions of the worth to the country of improvements in this important field, which should enable preliminary structuring of the priorities and programmes.

The Marine Economics Division has carried out quite a number of small benefit-cost studies related to facilities changes in ports and harbours. Of major importance this year has been work done in assessing and forecasting seaway traffic related to the future needs for enlarging or twinning the locks. The assessment is being carried out by an inter-departmental committee and is not yet available for discussion or publication.

In a somewhat similar category a joint study is being carried out in conjunction with Marine Services for the development of a new national harbours policy and proposed re-organization of harbour administrations. This division serves on the International Joint Commission studying the Great Lakes water levels.

In connection with work undertaken by consultants for the Branch in recent years, increasing use has been made of operations research people, particularly in the development of simulation models, mathematical programming techniques and other total systems approaches.

The experience gained by consultants has been to a certain degree lost to the department, although we have obtained title to computer programmes when these have been developed as generalized solutions having applicability elsewhere.

In view of the fairly intensive planning activity necessary in the immediate future, particularly related to airports and urban transportation, but also involving many other aspects of air and marine services, we have been asked to establish a small operations research division.

Staffing is now in process; there are at present small operations research units in both Air and Marine services. It is anticipated that the new division will provide headquarters co-ordination, stimulate the inter-

change of techniques drawn from industry, universities and research sharing with other countries and deal with the structuring of solutions to some of the more complex problems for which time or resources may not be available in the other units.

The outlook: the National Transportation Act made provision for the establishment of a research division in the Canadian Transport Commission. This division is now in existence and I understand you will be examining them tomorrow.

Research responsibilities between the Department and the Canadian Transport Commission are being divided on the basis that research in support of the operational requirements of the Department, the Canadian National Railways and Air Canada, as well as the urgent essentially short term requirements of the Minister and Deputy Minister, will be met within the Department.

Included also would be the means to deal with appeals to the Minister from decisions rendered by the Commission and to some extent the provision of an independent source to examine policy recommendations of the Commission.

The research division of the Commission will correspondingly be freed somewhat from interruptions and changes of priorities caused by urgent requests arising from the needs of the Minister and Deputy Minister and will concentrate on the longer term and intermodal aspects of developing adequate, efficient and economic transportation systems and their criteria.

You may find in the course of your deliberations that the proportion of total research effort devoted to seeking solutions to transportation problems in relation to the national cost of providing transportation, leaves room for acceleration of research activities by a number of agencies. This is the view that I hold. Thank you.

The Chairman: Thank you very much. Now, Mr. Williamson.

Mr. H. J. Williamson, Director, Telecommunications and Electronics Branch, Department of Transport: Thank you, Mr. Chairman and honourable senators: the opportunity to appear before you and tell you something about the research and development activities of the Telecommunications and Electronics Branch of Air Services of the Department of Transport is appreciated.

I feel that the efforts in what is more properly known as applied research, where we apply known technology to solve problems and meet the operational needs of those branches, services and agencies which we generally refer to as our customers are for the most part rewarding and always challenging.

I would also like to make sure that our reference to being part of Air Services is not interpreted in a highly restricted form, since our responsibilities extend into several facets of Marine Services, as well as being involved in the Meteorological Branch activities along with those related to civil aviation and, of course, to care for the needs in our own Telecommunications and Electronics Branch.

I feel I am particularly fortunate and should I also say more secure in appearing before you this morning in that I am pleased to have associated with me Mr. Frank Bentley, who is Chief of our Research and Development Division and, therefore, well qualified to answer detailed questions relating to the equipment and systems activities that are going on or have been completed over the time covered by our brief.

Perhaps I am a little different than my colleagues in the format that I am following, but I think that I should not take more of your time in this vein at the moment. However, Mr. Bentley and I shall do our utmost to answer your queries or to elaborate on items in our brief which you may be interested in, or any other matters of interest in which you feel that our sphere of competence is involved.

Thank you, Mr. Chairman.

The Chairman: Thank you, Mr. Williamson. Now, finally, Dr. McIntyre.

Dr. D. P. McIntyre, Chief, Research and Training Division, Meteorological Branch, Department of Transport: Senator Lamontagne and honourable senators: it is a pleasure for me to express on behalf of our Director, Mr. Noble, the Meteorological Branch's desire to contribute to your proceedings here. We feel that this is an extremely important work that you are doing and that we can in some way contribute to it and we certainly hope to do so.

The meteorological service perhaps is one of the oldest and we hope one of the most revered scientific services which the government has, since it predates Confederation by several decades.

I might say that I am very pleased to be able to represent the Branch and to try to answer any questions which you might have.

Contrary to what you might think, this will not really be a lantern slide show here; I am merely trying to bring modern technology forward in presentation of our brief so that we can add some of the visual aspects to the spoken word and hopefully make it more intelligible.

Also, my statements here may be slightly longer than the others and I am sorry for that but our brief was in a rather different form and based on rather different principles, so that I have to back-track a little to give you some of the information which you might have hoped to have seen in the brief, but which you will not find there.

First of all, the Metereological Branch has some objectives which I hope can be read here. You have a sheet before you which gives a more complete version; mine will be a slightly abbreviated version, but the main objective of the Branch is to provide metereological service for the benefit of the people of Canada through the extension and application of all aspects of atmospheric science.

We can break that down into some sub-objectives: the first one really is to provide information concerning the atmosphere. These are our services and this is our main purpose for being in being, to provide these services to Canada.

Secondly, to engage in, encourage, assist and promote meteorological science in Canada. In other words, to be a spark plug.

Thirdly, to act on behalf of the Canadian government in those areas where we have this kind of competence, particularly where we have an organization in a specialized agency.

Now, this really covers the meteorological aspect, but we have a few other things thrown in from time to time, so we have one more sub-objective: to undertake assigned responsibilities in other allied scientific fields, the main one at the moment being in ice, since we have a large network for observing ice in navigable waters, particularly in the Arctic and, as well, all the navigable waters around Canada.

Now, briefly, since we do not have an organizational chart in the original submission, I will indicate where we stand in the Department: the Director of the Meteorological Branch is here; the Assistant Deputy Minister is here. The Director, of course, reports directly to the Assistant Deputy Minister there. Our headquarters establishment, of course, comes under here. There is a Regional Meteorologist; there are six regions of Air Services and in each there is a regional meteorologist who is responsible for meteorological activities. This man does not report to the Director of the Meteorological Branch, but reports through his own regional director of Air Services to the Assistant Deputy Minister there. So this is the line of reporting.

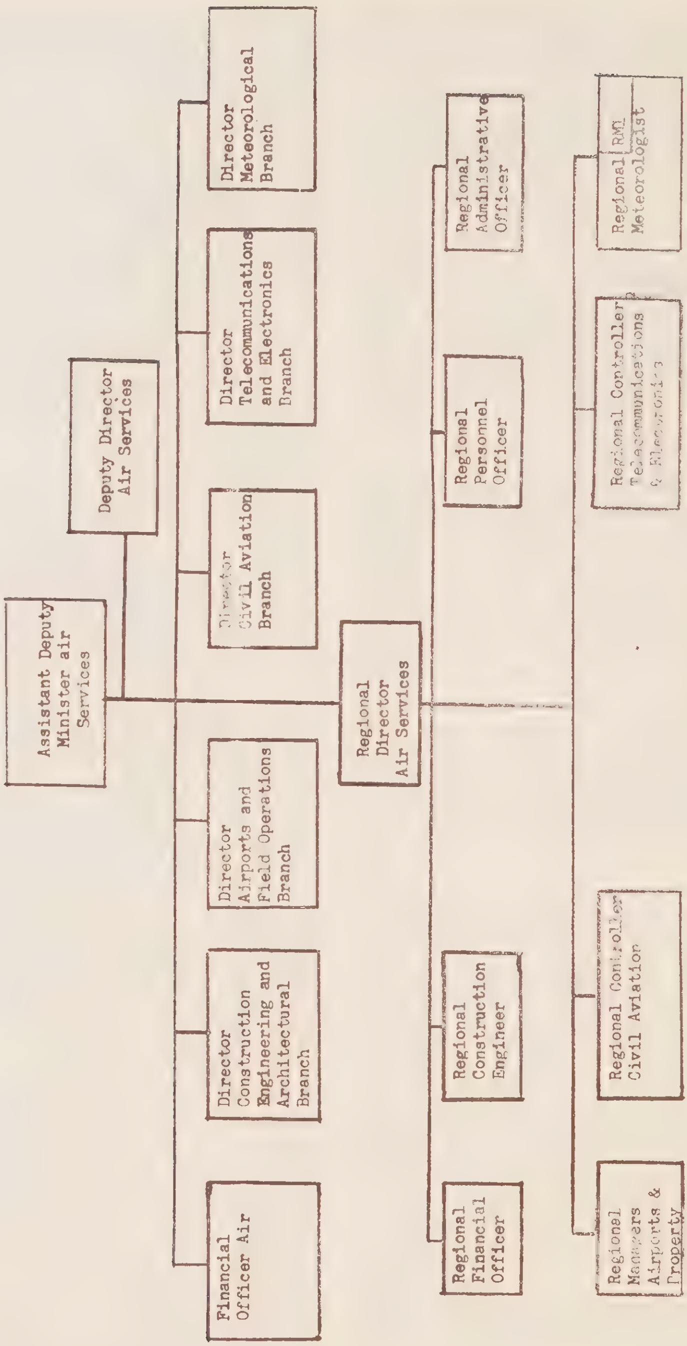
The other connection is that the Director of the Meteorological Branch exercises functional control over the activities of the Regional Meteorologist here.

In fact the meteorological branch organization is like this: the Director and subdivisions, plus meteorological services for national defence. In order to conserve our manpower, the meteorological service supplies manpower for meteorological services for National Defence, mostly for the air force, if we may call it that under combined services. These people are on our payroll, but work under National Defence; this man reports also through our Director and this is our means of maintaining liaison between the two sides of the service, so to speak.

Now very quickly, the administration division we need say little about; everyone has one. The forecast division is responsible for the full forecasting system across the country and making sure it operates properly. The instrument division is responsible for instrumental research, development, procurement and so on, to make sure, because we use a lot of it, that they are properly developed and standardized.

The basic weather division is responsible for our network and this is one of our biggest efforts, because data gathering on a very large scale on a continuous basis is one of our biggest efforts and takes by far the largest amount of money in the entire branch. These networks come under the basic weather division.

The two remaining divisions, the Climatology Division and the Research and Training Division are the ones where most of the research is done and hence most of the discussion today will probably be on the work of those.


Assistant Deputy Minister air Services
Deputy Director Air Services
Financial Officer Air
Director Construction Engineering and Architectural Branch
Director Airports and Field Operations Branch
Director Civil Aviation Branch
Director Telecommunications and Electronics Branch
Director Meteorological Branch
Regional Director Air Services
Regional Financial Officer
Regional Construction Engineer
Regional Personnel Officer
Regional Administrative Officer
Regional Managers Airports & Property
Regional Controller Civil Aviation
Regional Controller Telecommunications & Electronics
Regional Meteorologist
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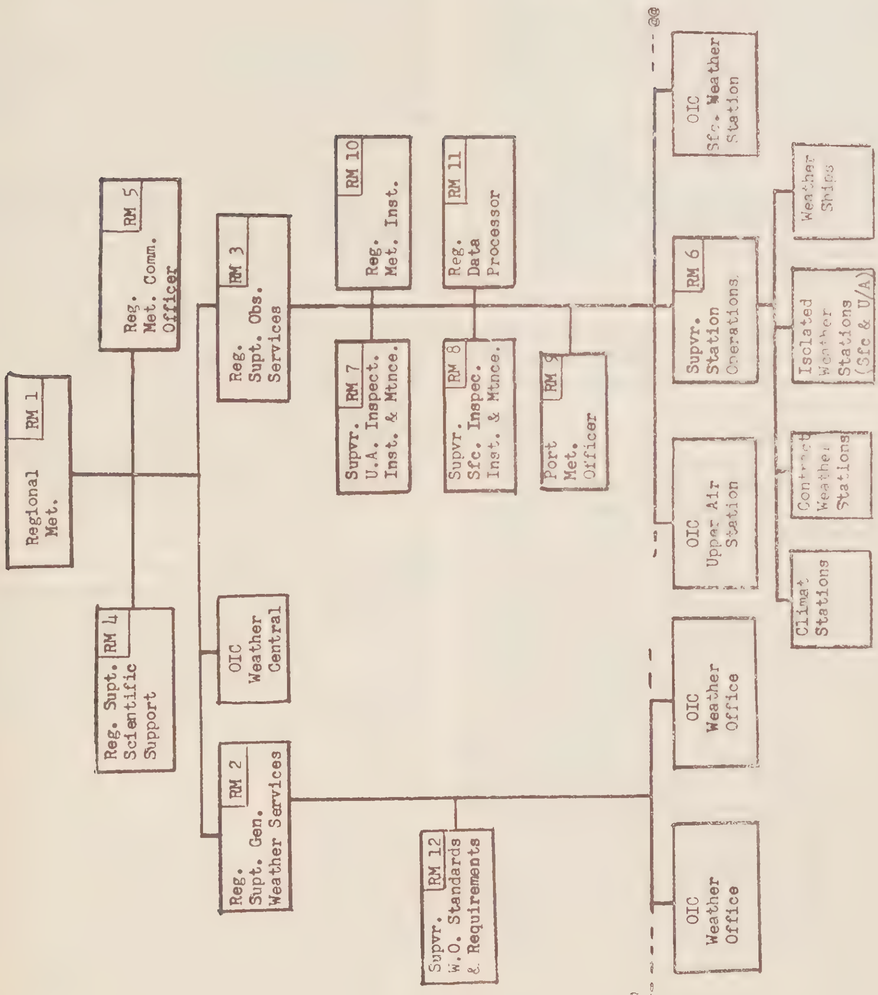

@@ Although only one Upper Air Station and one surface Weather Station are shown on the chart, there may be several in each category in any given Region.

...hough only two ...her Offices ... shown on the ...t, the number ...any given Region ... be considerably ...ier.

The Climatology Division, of course, maintains the large scale records and the computational machinery with which to draw out these tremendous numbers of records. There are hundreds of millions of punched cards containing those records and they are piling up at a tremendous rate.

The Research and Training Division carries out all the rest of the research, basic and applied research, particularly in support of the forecasting and all the training activities.

We run a number of schools and we maintain the standards, professional and technical standards, for the Branch.

In addition, we also operate part of the forecasting system. Since a large scale computer is necessary for the forecasting as it is done now the centralized part of the forecasting on a routine real time basis is carried out by the Research and Training Division, of course under the terms laid down by the Forecast Division.

On these charts, the numbers indicated at the top, 2.2, refer to the numbers in your guide, so this may be of some help in connecting it with the guide.

First of all we have the organizational functions, and the policies that we have developed over a period of time in connection with these organizational functions. The first of these is to use a system of resources where they are available. I do not think Canada can afford to duplicate its resources unnecessarily, so that this is a policy with us, to use existing resources where they are available. Initially, as you have got from the directors of other branches within the Department of Transport, we have a good deal of this kind of thing. We make extensive use of the resources of the Telecommunications and Electronics Branch, particularly, and especially their electronics abilities and understanding, their guidance to us and also procurement and maintenance of equipment. They also take many of our observations, since their people in the field are trained to take meteorological observations. This, therefore, saves us having more staff in the field.

Marine services also; we use their facilities. They operate the weather ships and facilities.

Then the government; we make considerable use, I will not go into details, of course, of the facilities of the National Research Council, the National Aeronautical Establishment, and the Defence Research Board.

We make use also of the universities they are a resource for us. We make use of their facilities when they can serve our purposes and theirs also. Industry, also.

Secondly, going in the opposite direction, not only do we use their resources, we supply the resources in return. I think it is necessary to have this kind of feed-back, so we support or co-operate with government services and research where we can make an input to theirs.

In particular we provide bases, particularly in the Arctic; most of the Arctic work which is done uses the bases which we maintain in the Arctic and the ships, which in turn, are mained by Marine services.

In addition we provide vast quantities of data of various kinds, oceanographic, climatological, radiation data and so on, for other departments of the government particularly.

In addition, we have what might be called contract work going both ways, where you have two parties, both of which are getting something out of the deal. We get greater value and so do they by co-operating in several projects of this sort with Defence Research Board particularly at the Experimental Station, where we maintain staff and with Marine Services and NRC and so on.

The next policy is for the building of our meteorological environment; by that I mean that if we are going to be fish we have to have water and it has got to be suitable to live in. We are concerned with the meteorological environment; universities must be healthy, the societies must be healthy, so must industry. The national and international agencies within which we must operate also, so we must ensure that we do all we can to ensure they are working.

Now with regard to major hindrances: one of the questions that was asked I think was a lack of a clear-cut science policy is one of the major hindrances that we are faced with. The better the science policy, the more easily we will be able to operate and the more easily we will be able to sell our programmes.

Major changes forecast in the future: I think the main one is that our work is becoming more and more mission-oriented. It has been in the past a considerable amount of basic work, for reasons which I will explain, and we are now becoming more and more mission-oriented as the results of these

researches come forward and end up in services.

Personnel policies: first of all we have policies for the encouragement of students to move into meteorology, because we have to acquire these people somehow and if we do not encourage them we do not get them. The first of these is the student assistance programme; it is a programme where we employ at least 75 people across the country, about half of them in headquarters, and a motivational programme which is intended not to get work done but to motivate these students. So they work with good projects. We have lecture tours to different universities across the country to present meteorology and bring the universities more and more into it and to interest the students of course. We provide fellowships; we are providing ten fellowships this year, which are comparable to the NRC Fellowships. These are tenable at Canadian universities for periods sufficient to bring the bachelor up to the doctorate degree, after which we hope to hire him, of course.

Our method of acquiring people initially is, first of all, people with a bachelor's degree we will employ, put them through a course in our own school to give them the professional background to carry out operational work in the field. These end up as what we refer to as metereological officers.

Another plan is the bachelor of metereologist's degree; we hire them and send them back to graduate school for two years and give them courses during the summers in between so that he comes out as a highly qualified professional meteorologist.

Then we also take bachelors with honours and give them fellowships to bring them up to the Ph.D.

We have some processes as well for upgrading their knowlegde; people can be sent on an education course for Ph.D. or for Master's principle requisites, in which case they go into the master's programme.

We have refresher programmes for keeping people up to date, because we have perhaps the fastest growing science in the world. We have workshops; we send the people out into the field to bring people up to date in the techniques and we provide considerable literature for people to read in between these programmes.

There is also the upgrading of the work level and I think this is important, the use of the technologists, because we have now technologists and technicians doing work for which we used to require a professional ten years ago, sometimes even a professional with a higher degree. A lot of this work is now being done by a technologist, so that the professional is free to do professional work, hence more challenge, and he is happier in the job.

Then we have the upgrading of the environment: if I may take the second one first, time for international organizations. If the international organizations, societies and so on, are going to be helpful, we have to supply people, give them time to work on these things and we do this; this is part of our policy.

The UN specialized agencies; we have a specific policy where we will allow as much as four men full time working in the secretariats, let us say, of these international organizations at any one time.

With regard to the research policies, project establishment and prorities, first of all, Canada's needs is our main criterion. If this is an area where Canada has a need for research to be done we move in or will support it.

Commitment to a Canadian scientific programme which the government has already accepted: science policy is not formed here as to which programmes will be accepted and which not; we may have a part of this and hence there is a commitment. I think we have spelled it wrongly, but at any rate we do the work; this becomes a higher priority if Canada has an interest in this field.

Canada's geographical location and size imposes certain responsibilities as, for example, it is impossible for us not to move into the field of sampling the high atmosphere, because we own too much of the geography of the world and if we do not do it, then our sovereignty is going to be overruled; other countries will insist on doing it. We cannot refuse the world this data, therefore it is important that we have programmes to obtain it.

Then, of course, finally there is the need of the meteorological services themselves for support, because we have a scientific service and services which require scientific support, which we supply.

Contracts and grants: we use all of these things. Let us take research grants first: first

of all, the criterion here is to meet the professors' goals and not our goals. We have research grants with the universities and these meet our goals and not the professors' goals. There is co-operative research with joint goals; for our development contracts, of course, for equipment requirements.

These basically are the policies.

Research output: you can just read that for yourselves; that is our research output for the last three years, to give you some idea of where we stand.

Conferences: I do not want to spend too much time on that; we go to the usual meterorological and cross-discipline conferences, some of them Canadian Met Society and American Met Society and various international conferences, but we also have some special ones, cross-discipline conferences, which are laid down for special purposes which I think are worthwhile mentioning.

This particular one is an example: World Metereological Organization and the International Civil Aviation Organization established a scientific and technical conference in London this year to which Canada made a considerable contribution and I think Canada's stature went up considerably from the contribution that was made at that conference, which will result in improved background for us in international civil aviation, particularly the supersonic transports which are coming in.

Then again there are other special conferences, such as the special one held in Vienna this year, to which again I think we made a very considerable contribution. This was on the peaceful uses of outer space and because of our technical know-how and because of our satellite technology which can be transferred and used at relatively small cost by underdeveloped countries, we are able to make a very substantial contribution to a meeting of this sort, probably more so than the bigger countries, such as the United States, which really have big efforts, which cannot be duplicated in smaller countries.

Obviously I am not going to list all of these; we gave a variety of facilities, some of which are laboratories. We have field facilities; we have mobile field facilities; micrometeorological trucks which can be wheeled out and work beside atomic energy plants to work out the diffusion characteristics before the plant opens. We have mobile radars, maintained of course by the Telecommunications and Electronics Branch; we have platforms, such as the Arctic stations and certain weather ships which can be used for other research work.

Then in the international centres: in the world of science Canada has been given the job of doing certain things on behalf of the world. One of these is the world ozone data publication; ozone is a relatively small gas in the upper atmosphere, but highly important, and Canada publishes on behalf of the world meteorological organizations the total world output on ozone data from everywhere.

Similarly, the North American Noctilucent cloud data publication; these are clouds which occur in the high stratosphere, two miles up; we publish these data for North America and they become part of the world system as the results of that.

We also operate the national radiation centre which maintains the standards for radiation and we recalibrate anybody's instruments according to these standards on behalf of the international bodies.

Coming quickly now to the scope of activity: there is the flow dynamics, the motion of the air from micro scale clear up to hemispheric scale; we study in all scales from the surface up to the high atmosphere of say 100 kilometers.

The physicla processes of the atmosphere: the climate; instrumentation to back these things up; fringe sciences, which are most important; they are pollution, hydrometeorology, ice in navigable waters.

The economic units affected: we affect practically everything economically; transportation, land, water, air, sea, supersonic transports, space, all depend on meteorology. Agricultural, forestry, water resources, oceanography, atomic energy, fisheries, building research, NRC, defence. To that you could add other things: health, and northern development.

Sample significant projects: just to put this in perspective, the wind-wave project, which I think Mr. Ripley indicated, is really a marine project but it has a substantial meteorological requirement before the marine part of the project is finished. This is applied research, mission-oriented in support of Marine Services requirements and in co-operation with Marine Services and NRC.

The Alberta Hail project: this is a tremendous project; crops are lost continuously because of tremendous hail; this is basic and applied research into the structure and physics of these storms. It is also co-operative with the Alberta Research Council and the National Research Council. It is a scientific study; part of it is contracted out to McGill University, so you can see the interconnections here in this one project.

APT: this is automatic picture transmission and the pictures which I gave to the Chairman here are some of those we obtained with our own equipment, which can be passed around so that you can look at them at your leisure, but with the automatic picture transmission type of thing we can use our own read out station to read from these satellites certain types of pictures which we can use in our own services and many other people need this information, so there is a whole new service being developed here. So we have been carrying out applied research and development to develop a satellite read out network, communications, data processing and the interpretation for many of these uses. So there has been throughout this co-operation with the National Research Council and the users and the major electronics support for this has been supplied by the T and E Branch.

Automatic weather stations: this is an instrumental type of development which allows us to move into research fields which we could not move into a few years ago. We have major projects in this area in support of the supersonic transport.

The Canadian Hydrologic project: I mention this because it is a major hydrologic project. This is part of UNESCO's international hydrologic decade, where they are going to study the hydrologic cycle, how the waters of the ocean drop down to feed the rivers and so on. It is the basis for the whole of water resources. This project is internationally set up; it runs from 1965 to 1974 and there are many co-operating agencies involved.

The present time—the effect of scientific activity on the meteorological branch are basic pressures: new technology creates demands for services and support and also creates means for services and support. World War II and after created many demands for services; it also created the money, which was not available before that and which is very necessary for the data which are required for these large scale operations and the equipment by which one could saddle the atmosphere. As a result of that we have been moving into a data gathering phase, where we use ground based equipment, radar, radiation networks, ozone networks, for sampling the ozone, micro-meteorological networks in respect of air pollution, automatic stations and then the laser is now moving in too.

We have airborne sondes, as we call them, the standard type which measure the temperature and so on, ozone sondes, radiation sondes, and constant level sondes.

Then there are the airborne type of sensors: research aircraft; surface temperatures which are measured by radiation sensors so that you can fly over a lake and measure its temperature and the satellite, of course, which is a revolution in itself.

As a result of all the data coming in data processing technology has moved ahead and this leads to new analysis methods. Communications is a part of this radio, teletype, facsimile and the satellite itself. The computer is an electronic computer which now draws the weather maps that we used to draw by hand, as well as calculating the forecast for the future.

Statistical techniques for the handling of these tremendous quantities of data have moved ahead and we have helped them move ahead as part of our research has been in this field. Data storage and the different types of analysis to the mathematical modelling of the atmosphere has also been a part of this.

As a result of all this, there is really an explosion in meteorological research in all fields and I think we are now moving into the theoretical field, because you move from the new knowledge to the new techniques to the theory and we are now moving into the theoretical part of this. I am speaking of meteorology as a whole and not just as a branch.

Part of this depends on the meteorological departments in universities, a phenomenon in itself. If you go back before the war, there was only one department of meteorology on this whole continent; that was at MIT. There are now about 40 in the US; a few major ones in Canada and there are some minor ones in Canada which could become major ones.

So that this is the environment within which we are now growing in meteorology.

Thank you.

The Chairman: Thank you very much, Dr. McIntyre; Senator Cameron?

Senator Cameron: Mr. Chairman, gentlemen: in looking through this brief it is rather obvious that the main emphasis is on applied research, rather than basic research and this is natural. This makes it I think easier for a group of laymen like ourselves, because we get a little closer to the day-to-day problems.

In going through it I was interested, I am following the outline now, in a comment which intrigued me a little bit. It could be serious and maybe nothing, but on page 2, under Organizational Functions, there is an implication there I think: how many times has the Treasury Board turned down projects and what was the nature of these projects?

Now, this may not be a good question to start out with, but I was just intrigued by that, because the scientific establishment of this department is not large and I can see where there might be some difficulties, particularly in the higher levels of scientific personnel.

Are there any problems there? I just made a note there: how many times has the Treasury Board turned down projects and what were they?

Now, this may not be politic to answer regarding the project, but the point that occurred to me was that in highly specialized work I am wondering if the rules of the Public Service Commission can be applied as they are set up today?

Mr. Hewson: Perhaps I could answer that for the department. This was in reference to the marine hydraulics submission, but I think it is a generalized question. The Treasury Board, as an outcome of the findings of the GLASSCO Commission, has been attempting with a considerable degree of success to try to quantify and forecast future benefits before embarking on any large-scale programmes. I think that people working in the research area have more difficulty in justifying programmes than some of the more practical construction and project type applications.

As a generality also, we have not had difficulty with the Treasury Board in regard to research; as a matter of fact, we have had a great deal of co-operation from them. There could have been and do occur from time to time specific projects where they may ask a question such as "could this be deferred a year?" if it involves a large expenditure of money and where the results are perhaps not going to be well defined. In general this is a co-operative arrangement and I do not think it represents any unilateral action by the Treasury Board; our relationships have been quite satisfactory.

Senator Cameron: I think the implementation of the GLASSCO Commission's recommendations are important; one of the objectives, of course, was to avoid duplication and waste of funds. I just wondered what the effect of this is.

Dr. McIntyre: In this connection as it affects us and I am sure the others are the same, the GLASSCO Commission report has been implemented to a certain extent. It used to be that in putting forward research activities the whole thing was looked at at the higher level activity by activity and perhaps sliced or altered and you would get back a programme which might be unworkable because they had cut out a part which was necessary to make the whole thing work; this was poor, but it has been more and more a matter of looking over the entire programme and then providing the funds, then allowing enough leeway so that things can be moved around.

So I think this type of hamstringing effort has been disappearing pretty fast.

Senator Cameron: This is really what I wanted to get at, because people who may not be knowledgeable in the field doing just as you said, cutting out an element of the programme, might tie up the whole programme, which underlines the importance of having somebody able to get to the Treasury Board to actually give this picture pretty clearly.

It again comes back to the question of the need for a science policy and who makes the decisions.

The next one was on page 3; this has to do with the argument that has been made from time to time about the keeping of the St. Lawrence Seaway open, even up into the Great Lakes.

Now, some people think that it is a waste of time even to keep it open to the Port of Montreal. My question is: is there no eco-

nomic way of ultimatedly keeping the seaway open and if not, is adequate research being done on this project? That is the first question.

Mr. Ripley: I shall try to answer that, Mr. Chairman, if I may.

The Chairman: It might be a joint answer.

Mr. Ripley: Yes; actually it was not too many years ago when many people felt and took the view very strongly that nothing could be done to provide winter navigation in some of our navigable waters. The view was taken, of course, that the forces of nature were just too large, too strong and could not be overcome. However, in spite of this, improved technology in ship operation, shipbuilding, new ideas about why we have ice of certain characteristics in certain areas, improvements in forecasting the weather, such as has been explained by Dr. McIntyre, these things have all shown very definitively that improvements can be made in winter navigation.

Indeed, we have evidence of that, that navigation is virtually a fact in winter into Quebec City where not too long ago it was not accepted at all, and indeed there are ships now going to Montreal where within relatively recent times there were not.

So I would suppose that as we improve our techniques and more research is done on this question, and which indeed is now going on, that further improvements will be realized.

Senator Cameron: Do you think it is likely that there will ever be a sufficient economic advantage to justify the cost of keeping the seaway open?

Mr. Ripley: I will allow Mr. Hewson to answer that question.

Mr. Hewson: The seaway itself as a transportation system is in competition with other surface modes, in particular, pipelines, where there is a large amount of oil presently moving by water that has the potential of moving by pipeline, also in competition with railway and highway networks.

Now, the case for year-round operation of the seaway I think perhaps Mr. Ripley could support in detail as to the technical complications involved and the degree of certainty to which the season can be extended, but the economic situation is not nearly so clear as navigation of the lower St. Lawrence into Montreal.

We are not in a position at this point in time of having any clear picture on the positive side of extending the season for the seaway itself.

Senator Bourget: The difficulty you will encounter in leaving the seaway navigation open all winter will be probably with the locks. Have you made any research or any studies so as to overcome that difficulty?

The Chairman: This is a technological question.

Senator Bourget: Yes, but it enters into the field of research also.

The Chairman: Yes, but not economics; it may at the end. Everything at the end is economics.

Senator Bourget: Well, it followed on Senator Cameron's question.

Mr. Hewson: Well, Mr. Ripley can refer to the subject at any rate, and outline what has been done.

Mr. Ripley: Actually there are a good many ideas explored focused on this very question and you are correct in saying that the lock areas, taking the case of the problem that lock areas definitely are the critical area as far as the seaway portion is concerned.

The seaway authority for its part has done and is continuing to do a great deal in regard to removing the ice out of the lock areas and as a result there has been some modest extension in the navigation season. If my memory serves me correctly, in the approximately ten years that the seaway has been in operation there has been an extension of the season into December of the order of two weeks I would say. Some of this has been good fortune, due to the weather, but on the other hand some of the improvements in new techniques have been of considerable help as well.

As to where we go from there, I frankly cannot say. There are thoughts expressed in many areas for heating the water and this kind of thing, sitting thermal generating stations, atomic power stations near these critical areas, but we in our area are certainly not doing anything in the way of research on this.

There are other people, I believe the Defence Research Board and possibly the National Research Council are doing research on this very point.

Senator Cameron: Relating to that, I have another question and it is on page 6, referring

to winter navigation in the St. Lawrence: how long is the closed season now, and is it economic to keep the port open up to Montreal? You say it is up to Quebec a good part of the winter now, but ships have been coming into Montreal increasingly in recent years.

Is it a month, six weeks, two months?

Senator Bourget: All winter.

Mr. Ripley: I think it is correct; if you are from Montreal you would say it is never closed.

Senator Bourget: I am from Quebec.

The Chairman: If you are from Halifax, you would say that Montreal is always open.

Mr. McIntyre: In this connection, it might be of interest to know that the satellite is becoming a useful tool here; one of the pictures I brought up shows the ice piled up on the eastern side of the lake and you can see it in the actual picture.

Senator Cameron: Every innovation has its side effects; what would be the effect if we do get the winter navigation into Quebec City and to Montreal? What will be the effect on the Atlantic ports? That is one thing.

Secondly, the new trend in the bulk carriers is to the huge, 200,000, they are talking about 300,000, in fact the Japanese have a 500,000 ton carrier in the works. Now, the St. Lawrence Seaway, the ports of Montreal and Quebec are not likely to be affected by this type of bulk carrier; they would never take those, or would they?

Mr. Hewson: Perhaps I could speak to that, Mr. Chairman: the present channel, and Mr. Ripley can confirm this, in the St. Lawrence is maintained at 35 feet and we have undertaken some preliminary studies as to the possibilities of going to 39 feet and to 45 feet.

Thus far we have not been able to prove an economic case for this, so that the bulk carriers which will be deep draft vessels, the present ones are, will be berthing at a limited number of facilities on the eastern seaboard.

On the other hand, the container ships which are also developing very rapidly may be expected to penetrate the St. Lawrence, as far as Montreal at least.

So we have these two developments proceeding somewhat differently.

Senator Cameron: There has been some discussion in the papers and at some government levels about the building of a huge new port capable of taking the largest ships in New Brunswick.

Senator Bourget: And Halifax; which has to do with the land bridge most particularly.

Senator Cameron: Yes, that is right, but in the foreseeable future would you not anticipate that large bulk carriers would come up as far as Montreal? They might come to Quebec.

Mr. Hewson: We could not provide an economic basis for creating the channel at the present time; not only are we faced with the competition from our own Canadian ports, but also the large American ports which are geographically closer to the centre of Canada, so that I do not believe that in the near future there will be any case for a substantial deepening of the channel to accommodate this type of vessel.

Senator Bourget: I understand that it might be difficult from Quebec to Montreal, because the channel is narrower there and the depth, as you say, is around 32, 34 feet, but to Quebec City as I understand it, there is only a stretch there, the south channel could be developed there; I understand that your department is looking into it, so I am wondering if you are making research for big ships, deep draught vessels that could come up to Quebec at least if some area and this area in particular down from the Ile d'Orleans, let us say, down to Riviere du Loup, you have got deep sea there, so I was wondering if some studies had been made or will be made to get this transportation up to Quebec. Up to Montreal it may be, as I said, more difficult.

Mr. Ripley: Yes; I shall be pleased to attempt to answer that question: it did not come out clearly in our brief, but I should explain that a substantial research endeavour is underway in respect to the very points you are bringing up. East, or northeast from Quebec in the River beyond Ile d'Orleans, there is of course this limiting section and at the present time we have a group of people who are actively engaged in analyzing it from every standpoint to see if there is an economic way, I mean a minimum cost manner in which we can keep that channel at the depth which would be indicated by the demands for ships upstream at that point. So this is indeed going on and I believe when Mr. Hewson referred to economics it would be a case of comparing, as well as the general economic

position country-wide, the costs of whatever we are proposing relative to the benefits which would accrue.

So our engineering activity and this research activity is actually a part of the benefits cost analysis and these things are to some extent a continuing type of activity within the department.

I might, just to clarify one further point on this of particular interest in this area, say that there is a tide and ships of draughts up to 45 feet can now come to Quebec City if there are facilities there, if there are cargoes for them.

Senator Bourget: Yes, I understand that CPR is looking into it and CPR has some plans to establish a container project there near Quebec.

I understand also that National Research Council has a model being made, a model for some years now, to study the feasibility. I do not know as far as the economics are concerned, but as far as the technical problem is concerned, National Research Council have made a model and are working on it for some years now. The Quebec area has been waiting for that study to come out with some results because, as we go along and as you know, there are bigger ships coming down to Quebec.

The Chairman: Are you aware of these studies?

Mr. Ripley: Yes, Mr. Chairman; I made some reference to this National Research Council study in my brief statement and as a matter of fact there are various things in our general brief which cover the same point.

The model study activity to which you have referred is a project initiated by the Department of Transport and The Research Council were invited to undertake what I would call the scientific part of this. We provide the funds in DOT votes.

This model is now well along; it is a large model, I assure you. It represents a section of the river from Montreal to Father Point. It is a tidal model; it is a very involved model and we hopefully expect to get the answers that you too are seeking when this model is in operation.

As a general comment on this particular study by National Research Council I might add at this point, Mr. Chairman, that when we undertook this study we had two objectives: one was to solve these transportation questions which the Department has an interest in; the other one was to provide an environment for the development of expertise in marine hydraulics associated with the extra-marine problem and I am indeed gratified that we have achieved the second objective already, because if anyone wishes to examine the activity that is going on in respect to this model they will be convinced that it is becoming an extremely fruitful source of specialists in the coastal extra-marine hydraulics field.

Senator Bourget: Is it the intention of your department to start to work on dredging, or doing some work in the south channel, because, as you know, the north channel is not too safe and there have been many accidents there. As a matter of fact I was one of the victims one day when our ship was sunk.

So I was wondering if the department intends after your research being made that you dredge or do some work so that the navigation could use the south channel?

Mr. Ripley: I can only answer, Mr. Chairman, by saying that it is part of the study.

The Chairman: We are going more and more into policy questions now.

Senator Cameron: Yes, I realize that. Just one that relates to it: under your research projects you mention the Champlain waterway feasibility studies; what stage has this reached?

Mr. Ripley: That study referred to here has been completed. It was a study undertaken for the International Joint Commission; the Department of Transport participated in the study in view of the internatinal aspect.

As I say, the study has been completed and the Commission I believe has actually made its report. The study was directed towards the evaluation of various improvements in the waterway for deep draft navigation and I believe the conclusion was that there were no benefits that would match the costs. Accordingly there was no recommendation to do anything on a large scale for navigation.

I believe there is also, or continuing within the department, a study relating to the recreational improvement of the waterway. This has not been completely resolved, but no doubt there will be a report on this in due course.

Senator Cameron: Well, you have given me the answer I wanted to elicit, namely there is

not likely to be any development in that area for some considerable time, if ever.

Could we switch now a little further along, to again page 6, the Great Lakes Water Diversion Studies. We read from time to time of very large projects for diverting water all over the shop; one proposal is to divert water from northern waters into the Great Lakes and raise the lake levels. This would have some effect on the seaway and some people say it would also be a tremendous advantage to the city of Chicago.

What about this?

The Chairman: This is an old one.

Senator Cameron: Yes, but it is coming up with increasing frequency.

Mr. Ripley: Mr. Chairman, I can only give a sort of a general indication of what is going on in this particular area: there is a study under the direction of the National Joint Commission again, the one that you have referred to, the one for the Great Lakes, and in the context of the study all these diversion schemes in and out of the Basin are being examined. I think that is about where we stand on that; there will be no stone left unturned, I am sure, in the Commission's study. They are making an extremely thorough investigation and in due course we shall know what the answer will be.

Senator Cameron: The reason I am putting some emphasis on these questions, with Senator Lamontagne says are quite far into the policy area, is because of the kind of lead time required to get the work done. Now, it may be ten years, fifteen or twenty years, therefore it is important that some group have a complete picture of what is going on, what is likely to go on, and the likely outcomes of certain studies; this is the reason I think it is important to get the picture of all of these projects now in order to help formulate science policies later on.

Mr. Hewson: Perhaps, Mr. Chairman, I can make a supplementary comment in that connection. Part of the work of the International Joint Commission, under one of the divisions studying the problem has been to create a mathematical simulation of the whole waterways network. This model has now been completed and is being tested for various correlations. There are some preliminary indications coming out but I think it is a little early to make a statement. In general the level of the water in the total system is now tending to maintain itself and some of these problems that you spoke of earlier with respect to Chicago are not as critical at the present time.

However, the outcome of operating with this model will, I think, provide adequate lead time in association with some of the work that Dr. McIntyre made reference to, ice forecasts, and actually water budgeting that is now possible through satellite data; it will be possible to have an adequate lead time to bring about diversions of water from the Hudson Bay watershed and what not in time to deal with the situation.

Senator Cameron: I have some other questions, but I am prepared to leave them out of this section now, unless someone else has something else.

Senator Kinnear: Mr. Chairman, I was going to speak about the research being mostly done from Montreal east and I was wondering what research you have done in the Great Lakes area?

You have spoken about locks, but I think you were referring to the locks that are east again and not the locks in the Welland Canal. I have a whole flock of things running through my mind that I wanted to ask, because you have left so much information with us that it is hard to get it all answered that we think about.

Also, Mr. Hewson, I was wondering are we not at high water now? The water is the highest in many years on the lakes, and that helps navigation greatly. What about raising the level at low water time?

All these questions are running through my mind but first I would like to know if you are doing any research other than the model of the new Welland section of the Welland Canal? What about the research you are doing from Montreal west to the southern Ontario Great Lakes?

Mr. Hewson: Mr. Chairman, the model that I referred to earlier, perhaps you are speaking of a different model, was a systems model of all of the rivers emptying into the Great Lakes Basin, measuring the flow of these rivers and measuring the water resources in the hinterland supporting the rivers and actually maintaining a running inventory of water resources with ability to forecast into the future as to the changes in levels. This is what is contemplated in the model.

With respect to the St. Lawrence or to the seaway itself and to the locks and facilities in the Great Lakes, there has been an interdepartmental committee studying the need for expansion of the locks or twinning the locks in keeping with the increased demands of shipping. The traffic forecasts, etc. have been completed; the committee's report is not yet ready for publication, so that I am not free to comment on it at this time, but there is almost a continuing study being carried out in regard to the facilities of the seaway.

The last impact that was made on the seaway was with the installation of marine traffic control. This brought about a quite substantial increase in capacity and allowed more lead time for expansion of facilities.

Running in parallel with this capacity increase, which was the result of research, has been the gradual replacement of smaller lakers by larger vessels designed to exactly fit the locks and achieve the optimum capacity. With both of these trends working, the effect has been to extend the usefulness of the present facilities quite considerably into the future.

Senator Kinnear: Yes, I realize that.

Mr. Hewson: Now, if I could answer the further questions, there is another interdepartmental committee studying the harbour facilities around the Great Lakes; a good deal of work has been done in the Toronto area and some of the other ports and harbour facilities. This is a continuing operation where the federal government funds certain improvements as the need for them becomes apparent.

Senator Kinnear: Thank you; there is a great deal I would like to ask as we go along but as I think of it may I ask this question: about two weeks ago Upper New York state seeded the clouds for snow, Dr. McIntyre, and it was quite successful. Are we doing anything like that in Research?

Dr. McIntyre: I can tell you a little about that is going to come anyhow. One of the Environmental Science Services Administration in the United States under the direction of its Cold Physics Laboratory, which is at Boulder, Colorado, with Dr. Viking in charge of this.

We are well aware of it; we are not doing anything on it, but we are watching theirs very carefully; the water resources side of the department is watching it very carefully too.

What they are trying to do is to determine whether it is possible to redistribute the snow that is going to come anyhow. One of the problems on the south side of the lake, and we get it on the lee side of Lake Huron, is with cold air coming across from the north across Lake Erie and Lake Ontario. The heat from below, because the lake is relatively warm, at least it is above freezing, causes strong evaporation to take place, giving convection and moisture which dumps a lot of snow on the south side.

Senator Kinnear: Buffalo gets several feet and we get very little.

Dr. McIntyre: What they would like to know is whether they can seed it at the appropriate time and spread the snow over several miles instead of dumping it in one place. It is really to determine whether this is possible.

Senator Kinnear: Thank you.

Senator Cameron: Mr. Chairman, I will not get into the Meteorological Branch, because the questions come thick and fast there, but on page 21 at the bottom of the page, you point out that Canada spent $5,000,000 in 1967, whereas the United States spent $278,000,000 on this.

Now, this is a huge difference and I am wondering can you suggest what you think would be a reasonable target for Canada, because increasingly we are running into problems which it appears that a greater knowledge of meteorology might be able to make a very great economic contribution to. I am thinking of hail suppression, rainfall control and all these sorts of things and this looked to me to be a very small amount of money, particularly in relation to what the Americans are spending.

Dr. McIntyre: Yes, it is; I do not think I can give you what I would consider to be an appropriate figure. I really have not thought of it deeply enough to give you a considered figure.

We really recognize also that it is much too small. This figure, incidentally, of course, includes the entire Canadian effort, the various parts of government and the universities. I think some of this has taken care of itself to some extent; that is to say the universities, for instance, are in a rapid growth stage. They started well behind the American universities; it is only within the last eight years or so that the Canadian universities have really moved ahead in this field.

So that I think that being you might say a gold stake, it will continue. So that what the government really needs to do is to make sure that these universities are funded for the kind of research that they dream of, that we give them sufficient money through, perhaps, the NRC or our own grants programmes, but that kind of government grants programmes to make sure that they have enough.

In addition to that there is, of course, the governmental type of research; programmes in Canada tend to cost more per person, because we own so much territory and we have to sample over large territories and bring it in over large distances in many cases. This costs a considerable amount of money.

Senator Cameron: In terms of the money spent, I know that if you were to ask to be allowed to double your budget now you would probably be turned down by Treasury Board, but another way of getting it is to provide a tabulation of the things that need to be done, a sort of calendar of projects. I am not sure what these would be, although I can think of some. If your department and your associates were to prepare the kind of projects you think we should be working on in the next 10 or 15 years in all of these areas, then you could start working backward from that as to the kind of financial support you would need. It might help to get more money for this area, because I am not sure we are developing it as rapidly as the needs of the time dictate.

Senator Kinnear referred to cloud seeding, and she talked in terms of snowfall, but we are concerned about rainfall, the distribution of rainfall, and so on. Some work is being done in hail suppresion, particularly in Alberta. I would like to comment on your evaluation of how successful it is, because the Denver people came up with one set of answers that seemed to satisfy the farmers paying for it, and I believe the report from the Meteorological Branch was negative.

Dr. McIntyre: I do not think "negative" in the sense we did not say anything, but we have made no statement it was unsuccessful. This was a commercial project. We have done enough evaluation tests to realize the tremendous difficulties in coming up with meaningful evaluations. Even with properly controlled scientifically designed experimentation, it is extremely difficult to get meaningful results. To take somebody else's project without complete information of the way the whole thing was constructed and measured, and the fact the thing changes year by year so that it expands and contracts and moves around, I would not like to say a thing about how successful it was. So, we have carefully avoided making any statement on the accuracy of their work, but we hope it was good.

Senator Cameron: You continue to observe it?

Dr. McIntyre: Yes, but we do not anticipate being able to get results from that. There is the possibility that within the next year or so we may be moving into a seeding activity in our Alberta project with the Alberta Research Council. We have been operating there for nearly 15 years, trying to build a model of what goes on inside a hailstorm. We are at the stage where we would like to tinker a little with some of the mechanisms and control work being done there, but I would anticipate it would be some years, even with that, before we would be able to state just how much we have been able to achieve.

Senator Grosart: I have had some difficulty in trying to discover from the brief what is the total expenditure in R and D by the department and how it is distributed.

We have the $5 million figure which comes from the Science Secretariat, on page 21. This is obviously a guess at the total expenditures in this area. I presume this is only in the meteorological area.

Dr. McIntyre: Yes.

Senator Grosart: But I do not find a statement in the brief as to the total amount you are spending on R and D and how it is distributed, say, between in-house, universities and industry.

Dr. McIntyre: I am not sure I can answer that in that way either. Unfortunately, we did not prepare the brief in the form you wanted it. We did not have the complete information at the time.

Senator Grosart: Perhaps I could say this, that scattered throughout the brief we find various figures, not conflicting figures. At page 37 it mentions $300,000 for the Met. Branch; a million and a half dollars, on page 78, by the Telecommunications and Electronics Branch; $700,000 on page 46, by the Transportation Policy and Research Branch. These figures are not very helpful unless they are pulled together.

Dr. McIntyre: I agree. We did not have your instructions when we prepared this and, unfortunately, we have not given you the information we can give you.

However, first of all, let me say a word or so on some of the figures. The $5 million is not the Meteorological Branch; it is supposed to integrate meteorology in Canada from all sources.

Senator Grosart: It is in their part of the brief.

Dr. McIntyre: Yes. The figures given in this Appendix 2, which you have referred to at page 37, are figures in support of scientific activities outside the branch which we fund.

Senator Grosart: This is only one branch.

Mr. Hewson: Mr. Chairman, might I just say it is rather difficult to draw a line between actual operational activities and research activities. They tend to merge in the Department of Transport. We have not attempted, and it would be a fairly time-consuming job, to compile a figure. These briefs you have are not the complete picture of the research carried out in the department. These are briefs pertaining to units carrying out a significant amount of research. In respect to this it would be a relatively simple matter to add up their budgets and produce a figure. We could perhaps give this to you today but a total, meaningful figure for the department would take some examination and investigation to produce. That is in respect of research activity.

Senator Grosart: I appreciate your difficulties, but this is the Science Policy Committee and one of the things we are concerned with is the total R and D expenditures in Canada, particularly by the Government, and perhaps one of our tasks is to advise the Government as to whether this is adequate or otherwise. We cannot do this unless departments are prepared to give us at least an informed guess. I appreciate the fact it is difficult to isolate R. from D., basic from applied, applied from technological and innovation. Everybody has this problem, but most of the other departments have tackled the problem and have come up with figures.

I would suggest, not necessarily now, but in the near future, it would be worth the effort. It might be time consuming, but I would suggest to you that if you are going to have science policy in the department, this job should be done. You should know. The deputy minister should be able to come here and say, "This is what we spend on research and development, and this is why."

If I could follow that up, we have the statement—again, I think in the Meteorological Branch, on page 21—that there is a trend towards a decrease in expenditures on R and D. This seems to be supported by some of the figures in your tables where the figures are projected. On page 78 there is a projection of figures into 1974 as to the operating and capital funds to be expended by the Research, Development and Programming Division, and which show, in effect, no increase. In fact, the figures show a decrease in expenditure in 1973-74 over 1968-69.

Dr. McIntyre: These are figures for another branch, I think.

Senator Grosart: Yes, and I mentioned the branch. Can you comment on the fact that at least one of your branches sees a decrease in R & D expenditures in the future? Does the department as a whole expect this? Is the statement on page 21—no, it is not page 21. I might mention here that one of the problems I have encountered in studying your brief—and I am not criticizing—is that it deals with the branches one by one, and one has to keep looking back in order to see to what branch certain statements apply.

The Chairman: I think, senator, that it is useful to have this kind of a breakdown. I agree completely that we should have an overall view, but it seems to me that it is very useful to have the information set out in this manner.

Senator Grosart: What I am asking for is an indication of what is likely to happen in research throughout the department. Are we going to see a decrease or a standstill in research expenditures within the department by 1973-74 as compared with this year? If so, why? There may be reasons for it.

The Chairman: There are various reasons.

Mr. Hewson: Let me say, first of all, that we will undertake to provide you as soon as possible with a total figure covering the research activities of the department as a whole. This is a rather difficult figure to come by, but we will have it for you as soon as possible.

Senator Grosart: And if you can, will you break it down into the performance areas as well as the funding areas?

Mr. Hewson: Yes, we will do that, sir.

So far as the apparent trend of reduction in expenditure on research and development is concerned, I think Mr. Williamson should comment in respect to Telecommunications and Electronics. He can explain that part of this branch has been broken off and given to the Department of Communications, and there has been a consequent shift of expenditures. There is also a corresponding trend in the shift of expenditures in the creation of the new Research Division of the Canadian Transport Commission. So, in viewing the research expenditures by Transport in their proper context you have to look at what is being done by the Commission and by the Department. We will produce for you the total of the Department's figures, and I am sure the Research Division will have current figures and forecasts for their expenditures.

Senator Grosart: That will be very helpful. May I ask a few more questions arising out of this? Are there at the moment any real centers of research excellence in our universities in the whole transportation field? I am not speaking now of meteorology, but of the whole field.

Dr. McIntyre: Well, meteorology is considered a physical science.

Senator Grosart: I might say that more than 40 years ago, when I was an undergraduate, we had a course on transportation under Professor Jackman, I think, and we were told that anyone who left the university without having a good grounding in the science of transportation would not be fit to live in this country. Have we centres of excellence in the transportation field now in the universities?

Mr. Hewson: Perhaps, Mr. Chairman, I could comment on that. We have been funding a centre at the University of Manitoba, which has grown up gradually. At the present time our assistance to this centre is of the order of $50,000 a year. We have a considerably smaller program at the University of British Columbia, not on this "centre of excellence" principle but in the way of assistance to individual students' research and fellowships in transportation in general. That is being administered by the Transportation Economics section there.

Both the Commission and ourselves have been dealing with a number of other institutions. The University of Waterloo is desirous of setting up a centre of excellence in transportation planning, and we have been in discussion with them. As a matter of fact, these are the only three programs of any size that are going on at the present time.

There is, I think, not a general awareness among all of the universities, and this is going to be corrected by means of letters that will go out jointly from the Commission and ourselves informing them of the availability and extent of federal Government support. With the formation of the new Transportation Research Division in the Commission, an advisory council was appointed, drawn from the academic and business community right across Canada. These people are bringing some very good and constructive ideas to bear on the direction in which research should take, and the type of assistance that should be given to universities at this point in time. To summarize, there are not very many programs moving, but we expect this to change quite radically in the next two or three years.

Senator Grosart: The Science Council seems to put transportation second as a priority for national goals in research. Is it really so that we have not a top flight transportation facility in any of our universities?

Mr. Hewson: Perhaps I could have either Mr. Peel or Mr. Conboy from my branch speak to this point. They have been interviewing at the various universities for recruitment purposes quite recently. Would you care to comment, Mr. Peel? Mr. Peel is the second from the right, and he is the chief of the Railway and Highway Economics Division.

Mr. A. L. Peel, Chief, Railway and Highway Economics Division, Transportation Policy and Research Branch: Our interviewing has been in the field of transportation econimics, and there are a number of people coming out of the University of British Columbia in this field at both the Bachelor's and Master's level. The centre at the University of Manitoba unfortunately has not been going for a long enough time for there to be too much output from it. We are not involved particularly in transportation engineering people who are coming out of centres like the University of Waterloo. We have to go to other places to get transport economics people, because the demand in Canada is far in

excess of the supply. We have been going down to California, to Berkeley, and to Indiana, which is where the large centres in transportation in the United States are.

Senator Grosart: Are there recognized centres in the United States in respect of which you can say: "Here is a university which is really the place to go for transportation research or transportation science"?

Mr. Peel: Yes, there are recognized centres but, surprisingly not too many. I would suggest that there are probably five or six so-called centres in the United States.

Senator Grosart: Transportation looms rather larger as a problem in Canada in terms of our productivity than it does in the United States, and yet we have not a centre of excellence. I am amazed at that.

Senator Cameron: I can say that one of the most knowledgeable people in Canada on transportation economics is Dr. Hue Harries, who is now a member of Parliament. He carried out many studies for the Government of Alberta not only in respect of railroad transport, but also bus transport and pipe lines.

Senator Grosart: We have men like Lorne MacDougall of Queen's. I am surprised that a centre of excellence has not grown up around men like that. He has been an expert on transportation all his life.

The Chairman: You ask him.

Senator Bourget: What about MIT? I understand that MIT get grants of about $90 million from the U.S. commerce department and that they are making a lot of studies.

Mr. Peel: There are a number of centres in the United States, such as the transportation school at Northwestern.

The Chairman: If we could postpone this discussion I think we shall have some opportunity to come back to it this afternoon, and more especially tomorrow on the question of existing teaching facilities in the field of transportation.

Senator Grosart: I have another question arising out of the interesting discussion at the bottom of page 31. This in on the general theme, I would say, of the problem of the input of science into national science policy. On page 31 we have the recommendation that a science policy should aim at greater participation of scientists in the establishment of national goals. On page 33 we have the statement that there should be a federal Government agency charged with the responsibility to predict the general trend of demands on the Canadian scientific community. Is this a suggestion that this federal Government agency should be a department of Government headed by a minister?

Dr. McIntyre: No, sir. Perhaps I could answer that, this being our submission. The purpose of putting this in was that lacking other guidelines, which we did not have at the time, we were following your own terms of reference and trying to make some helpful comments.

The Chairman: At what time did you receive the guidelines?

Dr. McIntyre: Last Friday, sir.

The Chairman: Only last Friday?

Dr. MacIntyre: Yes. I am sorry, but there must have been some problem within the department. I suppose the problem was our being in Toronto. At any rate we did not receive them.

The Chairman: They were circulated in August.

Dr. McIntyre: I realize that.

The Chairman: It is a lack of communication.

Dr. McIntyre: I am sorry about that. We do not quite fit your terms here. Coming back to the question, the intent was not to in any way specify what this agency would be, but merely to say that something like this would be a help, whoever was able to do it satisfactorily.

Senator Grosart: I might say that I was very taken with the discussion on these pages. It is one of the best we have had, in my view. Then it is suggested that there should be the linking of resources for research to gross national product. The Science Council said we must not fall into this trap of linking gross national product to scientific expenditure. This would seem to be a contrary view, and I must say I agree with the contrary view. Have you any comments to make? This comes out of my opening remarks about the importance of knowing exactly what you are spending on research and development, with its relation to gross national product or to any other global figure in the Canadian budgetary picture.

Dr. McIntyre: The intent of this statement was really to say that a certain portion of the product of the country should be returned back into research in order that you are not completely living up to your total resources but would be building for the future. Whether the GNP index itself is the proper index I would not care to say, but it should be somehow related to the economic health and productivity of the country, simply on the basis that the more productive you are the more able you are to turn a certain amount back to do this, and the percentage basis would seem to be a reasonable sort of approach to use.

Senator Grosart: Thank you, sir. It is a statement with which I agree entirely. On page 26 there is a reference to air pollution and to your co-operation with other Government agencies. What Government agencies are in this field as far as your department is concerned?

Dr. McIntyre: Air pollution cuts across so many different departments and so many different kinds of interests that a degree of collaboration is essential. We have received from the Treasury Board authority to operate within a certain field in the sphere of air pollution; that is, certain areas of activity are ours by rights, so to speak. These certainly do not cover the whole field of air pollution by any means. In fact, the people most concerned are probably those in Health. Federally at least it is the Department of National Health and Welfare with whom we work most closely. In fact, we have assigned a man, who works here in Ottawa but whose boss would be in Toronto, whose job it is to sit in the air pollution branch of the Department of National Health and Welfare in order to know what is going on, assist them with their problems, to do research as far as we can do it with direct support, and feed back other problems to us. The head of our micrometeorology unit maintains a very close liaison with those in the Department of National Health and Welfare.

We have field arrangements, because many of the problems originate in the provinces rather than federally, particularly from the municipalities. They usually come back to us through the provincial health departments and back to the federal health department to fund. When this happens they can come to us and we give them advice on both aspects, and it may end up with them putting up a 300 foot tower fully instrumented to gather meteorological information which comes back and which we process in our own machine processing, and we would deal with it as though it were one big project.

There are some other specialized areas which might be worth mentioning. One is atomic energy such as when you set up an atomic energy plant, particularly now that they are becoming quite common, for producing electricity on a commercial basis. Take one plant established at Douglas Point. When you set up plants like this you must know what will happen to the material you put into the air; you cannot take a chance. It may be all right, but you must have people able to say that it is all right otherwise the problems that arise are too difficult. When this happens we send a mobile team out and have diffusion cites on the spot to determine what pollution characteristics can be expected in that area so that the operating unit will know what the pollution problems in the area will be. We work very closely with Chalk River on all their problems too.

Senator Grosart: Is your activity in this area entirely in the research field or do you have any control authority?

Dr. McIntyre: No, we have no control authority. We are advisers and consultants. We provide expertise. We also process some data but we do not have any control.

Senator Grosart: In the field of water pollution the Government has given the overall responsibility for co-ordination to the Department of Energy Mines and Resources. Has any department or entity been given any overall responsibility in the field of air pollution?

Dr. McIntyre: No, sir. No government department has complete authority in the field of air pollution. There are many departments with interests in it, but no department that has particular control. This may be partly because so much of it is really a provincial matter rather than federal. As is also water pollution.

Senator Grosart: We were told by Dr. Solandt that there are 228 official entities dealing with water pollution. Could you hazard a guess as to how many are dealing with air pollution?

Dr. McIntyre: By entities do you mean organizations of one kind or another?

Senator Grosart: Organizations with some official responsibility.

The Chairman: There must be really more than that, because all municipalities in Canada have something to do with pollution or should have.

Senator Grosart: I am taking Dr. Solandt's figure. I started with 28 and he corrected me and said it was 228. Is it the same kind of multiplicity as in the air pollution field?

Dr. McIntyre: I would say it is comparable. Whether it is equal I do not know. Certainly all municipalities are interested in it, and even industries, because it affects so much how they are going to operate. After a while they are going to have to change their methods of operation because pollution levels must be maintained at a certain point. So, everyone has an interest.

Senator Grosart: Would you say there is a reasonable degree of co-ordination of government research or government-funded research in this area?

Dr. McIntyre: I am unable to say as to the whole field of air pollution. There is a reasonable amount of it with regard to the meteorological aspects and I think it is not too bad for our present stage of development.

Certain universities have competence in the field and can provide advice and consultation on request by people in those areas. I think people who want advice on the meteorological aspects of it can get it, and I think there is a reasonable degree of research and developmental work going on in that aspect, but on the total air pollution part I could not really say because it is so much out of my field. I would be misinforming.

Senator Grosart: I think you are very wise not to hazard a guess. One final question, Mr. Chairman. On page 42 there seems to be a suggestion that, like some other departments who have been before us, you are having some problem with the Public Service Commission categories. On page 44 you say:

> The salary differentials existing between researchers and research administrators are not great; for example, an Economist 6 (Researcher) is paid approximately 9 per cent less than an Economist 7 (Research Administrator).

And it continues on. Are you having some problems in this area?

The Chairman: There is, I think, a more direct and more specific grievance which has been raised by your branch in that you say you are trying to be recognized as a kind of multi-disciplinary branch or service while at the same time the Public Service Commission persists in trying to restrict you to economics.

Mr. Hewson: If I might reply to both questions.

The Chairman: I am just quoting more or less from the report.

Mr. Hewson: In reference to your first question, senator, we do not view the small differential between a research administrator and a researcher as being bad. We feel that researchers should be paid as much as they can be to bring the most competent people into the area. The one specific problem we did list was that some departments of government coming under the Public Service Commission have difficulty in establishing classifications for positions, whereas some of the other branches of government, such as the Defence Research Board, are able to administer their own classifications. They have a little more flexibility in structuring jobs to suit people who are available and to suit the disciplines and needs of the branch.

In our particular branch we have been heretofore restricted mainly to economics. This says that if a promising young man comes along with perhaps very good training in mathematics, operational research or geography, without the necessary economics courses, we are unable to offer him sufficient salary to attract him because he is judged on the basis of his economics training, and this is not necessarily relevant to our problems at the time.

The Chairman: Yet your research program has been equally divided between economics and engineering. How do you accomplish that?

Mr. Hewson: We tend to have engineering done by contract consultants. We have had one or two engineers in the branch and we have people with training in other than economics, but it is a somewhat difficult problem. You did ask for problems and we set this out. We are in the process of negotiating with the Public Service Commission and I feel that this situation is going to be cured, but at the time of putting in our brief I mentioned this as a problem area that needed to be dealt with.

Senator Grosart: It seems to be an area from which everyone is anxious to opt out.

Senator Cameron: I had raised this very question on page 43 of the brief because it seemed to me that while there is a danger in giving every department freedom to make its own rules, I would have grave reservations about the Public Service Commission making a decision as to whether or not you should hire an economist-engineer or what you should pay him. I think this again relates to the very first question I asked as to what provision is made for co-ordination between these government agencies with respect to getting staff and is there undue interference. You said no to the first question, but your answer has implied that you do need a little more flexibility in being able to appoint people with multi-disciplinary backgrounds to your staff. I think you should have it.

Mr. Hewson: If I might comment . . .

The Chairman: You are in the process of negotiating.

Mr. Hewson: Yes. My first comment was a general statement relating to problems. These are not particularly common to our branch. I think they are the problems faced by any government department where there is an objective of trying to administer people fairly and maintain uniform differentials between similar skills and I think this objective of the Public Service Commission is laudable and we support it, but at times it brings about operating difficulties in staffing of positions.

Senator Cameron: On the question of fogs at airports, what is being done in this field in Canada?

Dr. McIntyre: We have some projects and a team which watches this. There are two types of fog at airports and usually different ways of dissipating. One is the so-called "cold fog" at temperatures of 6 or 10 degrees below freezing point. This can be dissipated by the same sort of technique as one uses in cloud seeding. This means injecting silver iodide. This chemical develops ice crystals and causes the whole fog to crystallize and drop out. Our studies of this have shown there are not too many fogs of this kind in Canada, strangely enough, and most of those which do occur are in Vancouver. Some tests are going on. Unfortunately, since the tests have been set up, we have had fewer than normal of these fogs to test.

With regard to the "warm fogs", we have given considerable consideration to going into this field. However, there are more airports in the United States, with more of this kind of fog and it is a bigger problem there than it is here. Since our technical group is not large enough to spread too thinly, we have been watching their experiments and we are up to date on what they are doing and on whatever successes they have had in the different methods they use. If such methods show sufficient promise to be economically feasible, we would bring them along to the Civil Aviation Branch of the Department of Transport, where the problem really lies.

Senator Cameron: That makes sense. If someone is doing the work in another country, we should use the information, rather than duplicate the work. How much information have we on the snowfalls and precipitation in the far north? I am thinking in terms of setting guidelines for settlement, industrial development and—perish the thought—for military operations in the far north.

Dr. McIntyre: We have fairly good climatological data for the whole of Canada. Naturally, it is more sparse in the northern regions. If one were going to develop a certain area, it would be advisable to move in and do a special study for particular areas which were being considered for this sort of purpose.

As far as it concerns a general indication of what things are like, we have fairly adequate data over a considerable period of time. At the present time, as part of the climatological research studies—and this has been contracted out to universities and several universities are working on it—there are special climatological studies for different areas which are being carried out, to provide overall climatology. Part of this includes the Arctic, where there is one study being carried out on climatology at present.

Senator Cameron: From the information we seem to have, we are just on the verge of a tremendous development in the far north, going up even to the American side, on both oil and minerals and also in terms of strategy. This is one of our vulnerable areas. I wonder how much information we have. My own feeling is that it is rather sketchy, but I may be wrong.

Dr. McIntyre: Are you thinking of the perimeters which might be useful for certain activities, such as agriculture?

Senator Cameron: I am not thinking of agriculture. I am thinking of living in the north, in connection with oil wells, mineral research, pipelines and so on. We need more information on conditions, and as to the kind of development we need for communications by air and road, both from the industrial or economical standpoint and also from the defence standpoint.

Mr. Williamson: May I ask, senator, whether you are familiar with the climatological atlas of Canada that we have?

Senator Cameron: Only superficially. The impression I have is that we need more detailed information than we have at the present time.

Senator Grosart: May I ask a supplementary? We read that the Russians know far more about the Arctic than we do, scientifically. Is that so?

Senator Cameron: They do.

The Chairman: There are very good reasons for this.

Senator Grosart: I am asking if it is so?

Dr. McIntyre: I think it probably is. They have sent study teams and spent considerable time in the Arctic and I think they do know it much better than we do. But for planning purposes we have at least a reasonably good picture of the Arctic, because we have operated in the Arctic for quite some time. There are good joint Arctic stations, one operated jointly by Canada and the United States, across the top—some of them as high as 70 or 80 degrees north. These have operated for some time and we know the problems regarding living conditions which one has to undergo there, the problem of maintaining life and also of maintaining airports so that people can get in and out if necessary during the wintertime. We have considerable knowledge of this sort of thing. I think that our experience in operating there has provided a vast amount of information.

Senator Cameron: Have you any information that would bear directly on pipelines, in those areas—effective temperatures, soil conditions, heating condition, the breaking of lines, and so on.

Mr. Hewson: Since the Prudhoe Bay oil discovery there has been a tremendous amount of interest in pipelines and in the geological formations along the Mackenzie delta, indicating very good possibilities of oil being found there in quantity. Both countries are moving very quickly, but I do not think that Transport is highly involved at this stage. They are moving very quickly into pipeline research, into methods of carrying oil at low temperatures, storing oil en route. We have an interdepartmental committee dealing with northern development, which has representatives of the Departments of Indian Affairs and Northern Development, Energy, Mines and Resources, NRC, Department of National Defence, our Marine Service, who do re-supply to the Arctic, Air Services who maintain air strips, the meteorological branch and the telecommunications branch. This is just now in the process of generating—if I may say so, in the colloquial sense—the steam to move forward. Also, we have a proposal in front of this committee, from the Arctic Institute of North America, to carry out research in this area. I am not able to comment as to the progress at this point.

Senator Cameron: What degree of information are you able to get from the Russians in this area? They have done a lot of work, obviously they have done something which would be very valuable to us. Is there a relatively free interchange of information in this area?

Dr. McIntyre: In terms of anything they publish, I think we would have no problems. We receive most of the major Russian publications and translate those which are of special interest, and there are translations in a variety of other places as well. So that, as far as published knowledge of this sort is concerned, I think we are fairly up to date. Our main problem really is to have expert interpretation, which might be more difficult, but even that is not impossible. The main problem really is to have expert interpretation, which might be more difficult, but even that is not too difficult. Our relations with the Russians are by and large pretty good. We did, in fact, send a team over there during this last summer to inspect their own hail suppression project, and there was no problem with establishing a team of that sort. In fact, they sent a team over here to look at ours right after that.

Senator Cameron: What provision is there for providing co-ordination between your department, the National Research Council and the universities? Is there normal machinery for co-ordinating your approaches to these problems in this area?

Dr. McIntyre: I think this depends on the particular situation. There is no formal, overall co-ordination for everything, but whenever problems which go across these boundaries come up, then everybody knows the right people so that they move in and carry out the proper conversations.

For example, with our grants program, there could be a conflict with the grants program of the National Research Council. However, it is established with the full knowledge and support of the NRC and there is an NRC man who sits on our committee when it meets. Our committee meets about two weeks ahead of the NRC committee. This is all for co-ordination purposes.

Sometimes we find that a person probably should be funded but does not fit too well under our grants program. The application is then passed over to the NRC and their man takes it back and it automatically goes into the NRC program.

The Chairman: Is NRC involved in research in meteorology?

Dr. McIntyre: Not very much. Most of their involvement is in our projects. They are involved, for instance, in this Alberta hail project mainly because of their expertise on the radar side. They did a redesign on the radar dish. We purchased it. They did all the work in setting up the contracts and doing a lot of redesign on the thing after getting it in and setting it up. They are also maintaining it. That is part of the kind of research they like to do. So that their support was really on the technological side.

The Chairman: It seems to me that you are mainly a servicing research organization which has all kinds of specific purposes. Since also you are more or less the sole agency within the federal Government involved at all levels of research in the field of meteorology, have you ever given any thought to the suggestion that it might be better if you were located as a kind of special division of NRC rather than being with the Department of Transport?

Dr. McIntyre: No. We have not really. I do not know whether this would be a good thing or not. At our present stage of development, I am inclined to think not, because of the fact that we have within our own confines all of these groups working together. They react on each other and this makes for bettwe work over all. And since most of our work is really in support of our own activities, it makes one, complete, integrated package. I cannot really see splitting off a portion of it and putting it in NRC. There is no convenient portion to split off. As a matter of fact, we have some difficulty because of the split that we now have in that a part of our forecast research team is in Montreal owing to the fact that that is where the central analysis office is. Their output is used there so we decided to put the team there, but that team suffers greatly by being separated from the other teams which could react on it.

The Chairman: I mean all your branches, all your service would become part of NRC. It would not be splitting your services.

Dr. McIntyre: I think this would be against the normal terms of reference of NRC in that a large part of the work of our branch is operational. That is we provide a direct service to the public.

The Chairman: A lot of NRC's work is operational as well.

Dr. McIntyre: Yes.

Senator Bourget: But not as much.

The Chairman: Wind tunnels and the like are rather operational.

Dr. McIntyre: I am thinking in terms of providing a direct service to the public. You see, we have our regional offices and the service to the public through them. Even dealing with air pollution, people can come in through our regional office so that channels are established whereby the regional people can provide them with knowledge on micrometeorology and air pollution and so on at a level that is within their limited knowledge of the subject. And yet they know that should they go beyond that they have the larger team back in Toronto and the channels for getting back up so that they can bring in the more knowledgeable experts in this area.

The Chairman: You could be part of NRC and still remain in Toronto, I hope.

Dr. McIntyre: Oh, yes, I would presume so.

Senator Bourget: Mr. Chairman, I would like to ask a question of Mr. Ripley, and it follows the line of questioning of Senator Cameron. I understand from reading your brief, sir, that one important function of your branch is to collect data. Would it be fair to say that that is the main function of your

branch and that whenever you get data you pass it on to either the National Research Council or to any other private laboratory so that they can do the research to solve the problem that you have to face?

Mr. Ripley: There is a unit in Montreal called the St. Lawrence Ship Channel Division, and the data collecting group falls within that division in what we call the Engineering Field Investigation Section. This section is exclusively concerned with improvement of the operating and development of projects for the ship channel. It operates exclusively in the ship channel and it devotes its attention to filling in details concerning possible projects, programs, that, in the broad sense, are actually of the kind of data that we get from Energy, Mines and Resources and several other Government agencies.

We are concerned about the details, for example, for a model study in the broad sense. We will get water information from Energy, Mines and Resources and then we will examine this and work our details within this general framework directed towards the model study activity.

Senator Bourget: But the model that you have on the St. Lawrence, for instance, is in the National Research Council and it is NRC that is doing the research that is needed.

Mr. Ripley: Yes. In so far as the model is concerned, they are designing the model, building it, instrumenting it, and they will operate it. They indicate to us the kinds of information they need that must be gathered in the field to make this model respond to the munipulations to which they will subject it, and this is where our people are brought in. They go out and they actually do the physical work of collecting the data, correlating it and passing it on to NRC who introduce this information into the model study.

Senator Bourget: Am I right in saying that you are not doing the basic research? Whenever you have some kind of machinery to develop you go to NRC or to laboratories like Laval Laboratories in Montreal.

Mr. Ripley: That is correct.

Senator Bourget: You have no laboratories?

Mr. Ripley: No, we have no facilities of this kind. We operate with the Department of Transport's staff. As I indicated, we try to keep a group of specialists, who are, in effect, a group of consultants, if you will. They act as liaison and do the co-ordination.

Senator Bourget: So there again it could be part also of the National Research Council, because all the research, as I can see, is done by the National Research Council or by private laboratories.

Senator Grosart: Mr. Chairman, I have a supplementary to Senator Bourget's question.

On page 39 it says:

> The Transportation Policy and Research Branch has no statutory functions and powers regarding scientific activities.

Does this mean you have no powers and no authority in a research branch to engage in scientific activity?

Mr. Hewson: If I might answer that since it involves a comparison between the Transportation Policy and Research branch and other arms or branches of government where by statute they are required to perform certain functions. For instance, the new division of the Canadian Transport Commission is empowered to do transportation research and is required to inquire into the means of achieving the most adequate, efficient and economic system of transportation. The National Research Council has certain statutory requirements, which it had prior to its founding. Our branch, in contrast, is not or has no requirement upon it to carry out certain stated functions. It has no requirement by statute.

Senator Grosart: You said it has no statutory power to do research. What kind of power could you have other than by statute? I am not asking this in a critical way, but it seems to be an overly defensive statement. You will find it on page 39 towards the bottom of the page.

Mr. Hewson: If I might say, senator, that that was not the intent of the statement. It was mainly for clarification. In your deliberations while reviewing various research units you will find some that are required to carry out certain functions.

The Chairman: But you have no obligations by statute to carry out research.

Senator Grosart: But they have the function and power by statute or they would not be called a research branch.

Mr. Hewson: It was not the intention to present a defensive statement. It was meant to clarify.

The Chairman: We will have to adjourn very soon, I am afraid, but I would like to ask a question of Mr. Williamson. as a result of this transfer of part of the activities to the Department of Communications would you describe more or less briefly what is implied in the terms of this transfer to the new Department of Communications?

Mr. Williamson: Yes, sir, in the broad general sense briefly, in the Department of Transport we were responsible for all governmental communications policy and also involved to a considerable degree in operation of facilities which the Government has and to render services to the various agencies where we are in an operating role. And perhaps just before the transfer of part of the Department of Transport telecommunications capability to the new department we had seen fit to split the policy and regulatory functions of the Telecommunications Branch into a group which came to be known as the Telecommunications Policy and Administrative Bureau. It was this entity which dealt with matters such as the regulatory functions, the licensing of radio stations, the technical expertise that is now provided to the Canadian Radio-Television Commission, the allocation and use of radio frequencies and management of the frequency spectrum. These functions in the regulatory field were transferred to the new department. The matters of dealing with international policies relating to the activities on a world-wide basis of the International Telecommunications Union and its specific organs particularly the committee for telephone and telegraphic policies, and another one which is known as C.C.I.R. which deals with a consultative committee on radio and radio standards. The involvement of the department of government in policy relating to technical matters in the field of the international satellite consortium and dealing through the Canadian designated organ of the Overseas Telecommunications Corporation also come in the policy area, and they are now reporting through the other minister. Then we were in the state of developing an increasing competence in dealing with the details of policy which would be necessary on national telecommunications matters relating to matters of internal communications in the country and dealing with common carriers of communications such as railway telegraphic people and telephone companies. These two are in the new department.

A portion of the research and development area which was related to communications satellites was also split off.

The Chairman: You say "a portion"?

Mr. Williamson: A portion of our research and development staff that had a competence in satellites was taken off and transferred to the new department, but when they were transferred they were not maintained as a separate entity. The capabilities of this staff were infused in the various sections; one or two went to the international group, some went to the national group and some went to the regulatory group because they felt it was probably an indication of a large segment of research area from D.R.B., D.R.T.E., Defence Research Telecommunications Establishment, which was also going to be part of this group, and this has materialized and according to the information I have on the proposed organization it will have the people involved in the ISIS program and the Alouette program and the satellite area forming a research group in this new department.

The remaining portion of our operations, and the part which I now have the opportunity of being responsible for the direction of, includes the operational side of matters relating to the transportation industry, and it provides expertise and also operates facilities directed to the air transportation group and also is related to the marine group in providing aids to marine navigation and some that are used for our coastguard operations as well as certain communications on the high seas on a commercial basis on the east and west coasts. We have of course in the aviation side the responsibility for the maintenance of operations, and I should preface this by saying that we are also responsible for, first of all, the research and development as necessary where new gadgetry has to be found. Then the design and the construction of some of these facilities and, ultimately, the maintenance and operation of the facilities that provide aids to air navigation—the instrument landing systems of airports, the en route navigation aids, the air-ground communications that are related to the control of aviation, and, in some instances, we provide facilities for airline companies rather than

them providing their own air-to-ground communications services.

Then we maintain the facilities used by the air traffic control people in connection with the radars they use for en route surveillance and airport and terminal surveillance, and the landing operations they use in connection with traffic control and also the communications they use at remote points and the main airports. Sometimes we have control circuits 200 or 300 miles, where a fellow, say, in Montreal may be controlling aircraft over a radio station located 200 miles away.

On the Marine side also we provide design services in the matter of equipping the Coastguard ships with their navigational facilities, and in some areas we also provide other electronic gadgetry abroad the ships related to communications.

We have also been involved in providing communications for marine traffic control on the St. Lawrence system, and work closely with the Marine people in devising improvements for their operations.

As Dr. McIntyre has mentioned, we are involved with the Meteorological Branch and provide facilities, services and advice to the Meteorological Branch as well as maintaining many of the electronic gadgetries they employ in making, for example, upper air observations where they send up balloons with little radio transmitters on them, and information is brought back and interpreted and transmitted along the various collection networks.

We also operate a teletype service across the country which provides information on the movement of aircraft on an international basis and tied in with the world wide exchange of information with jets travelling here and there at a fairly rapid pace.

We also provide advice to the meteorological people in connection with the acquisition of teletype and similar types of equipment they use for the collection and dissemination of their weather information.

I think this gives you a rough breakdown of the relative responsibilities and what was transferred.

Going back to the part of the Research and Development area with respect to satellite competency, we are also still involved in the international aspects under ICAO, the International Civil Aviation Organization, and the studies which are going on about providing satellites for position fixing for aircraft and/or marine uses, and the possibility of utilizing them for more accurate air traffic control than is now possible over large expanses such as the North Atlantic, where the positioning or definitive fixing of aircraft in space across the Atlantic is one of the major traffic problems.

So, we are involved in studies of that nature and currently are assembling equipment for experimentation in northern latitudes with communications which are being exchanged by aircraft via experimental satellites at the present time in order to get the effect of the auroral zone on the transmission from the satellites which are located over the equator in a synchronous orbit configuration. We are also very much involved at the present time in the automation of air traffic control and the capability of remoting data from radars and feeding this information over communications lines to central points, with the idea that we can superimpose various types of information on a radar screen which will facilitate the man controlling the air traffic. The automation will also include the storage and retrieval of certain data which may indicate conflict of relative positions of aircraft, so that many of the pressure problems that the controller is faced with will be put to the machine. This is taking a fair amount of our time.

The Chairman: How many of your people who were involved in research would you say have been transferred from your department?

Mr. Williamson: There were only seven, sir.

The Chairman: Only seven?

Mr. Williamson: That is right.

The Chairman: I have two very brief questions. You mentioned, I think, Mr. Hewson, that you had presented a brief to this commission on housing about the plans and programs for this new urban transportation division.

Mr. Hewson: Yes, sir.

The Chairman: Did this involve the research program that you were envisaging?

Mr. Hewson: This was proposing the structure of the research program.

The Chairman: I do not want to spend any time on this at the moment, but when you send us the additional information we asked

for this morning will you attach to it this brief?

Mr. Hewson: We will be very pleased to do that, sir.

The Chairman: Finally, how will you divide the work from now on with the Canadian Transport Commission? Will this change your research operation in the department very much, or is the Commission going to fill a gap?

Mr. Hewson: Well, the Research Divison has been in existence in a very small state for approximately ten months. To date there has been no significant impact. Our needs for research have been increasing, and so have theirs. I think there has been such a dearth of effort in this area that it can accommodate the endeavours of both, and still leave a need for much more.

The Chairman: But, can you say that as the Commission develops its own research activities you will be even more restricted than you are now to development work?

Mr. Hewson: I would say that that is probably a correct forecast. The Research Division is much more comprehensive in its outline as it stands. They have a technology unit and an economics unit and a policy unit, and...

The Chairman: So your research facilities will be more or less limited to specific projects which come to the department, or to the minister, and perhaps also to advising the minister on the research that is being done by the Commission? You will not undertake, and you do not seem to undertake even at present, general research.

Mr. Hewson: We are not doing basic research, if that is your question. We are doing problem-oriented research, and I think this will continue. The role of the commission will be to deal with the broader problems and broader systems, whereas ours will be to seek specific solutions to particular problems that are facing the Department or the Government.

The Chairman: Like railway projects, special projects for deepening the seaway and things like that?

Mr. Hewson: That is correct.

Senator Bourget: Is there any liaison between your branch and the CNR research and development branch?

Mr. Hewson: We maintain very good communications back and forth. There is direct liaison at the executive level between the CNR and the Department of Transport. In terms of research sharing, each of us knows what the other is doing.

Senator Bourget: But the CNR research and development branch is completely independent?

Mr. Hewson: That is right.

The Chairman: Thank you very much, all of you. I am sure that what you will send us in addition to what you have already presented to us will be most useful.

Mr. Hewson: Thank you, sir.

The committee adjourned.

APPENDIX 19

DEPARTMENT OF TRANSPORT

BRIEF TO THE SENATE COMMITTEE ON SCIENTIFIC POLICY

OTTAWA
1968

DEPARTMENT OF TRANSPORT

BRIEF TO THE SENATE COMMITTEE
ON SCIENCE POLICY

O t t a w a

1968

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INTRODUCTION

The Department of Transport, in accordance with the Senate motion dated November 8, 1967 establishing a Special Committee "to consider and report upon the Scientific Policy of the Federal Government", takes pleasure in submitting herewith its brief in respect of this matter.

All aspects of the operations of the Department were examined, in the context of the scope of inquiry of the Committee, and it was subsequently concluded that five main areas of endeavour were engaged in activities apparently relevant to the interests of the Committee. Accordingly, this brief is comprised of five sections each of which has been compiled, in general conformity with the guidelines furnished by the Committee, by the appropriate reporting departmental branch or division. The five sections in question, set out in the sequence in which they appear, are as follows:

- Section I: Marine Hydraulics Branch;
- Section II: St. Lawrence Ship Channel Division, Marine Hydraulics Branch;
- Section III: Meteorological Branch;
- Section IV: Transportation Policy and Research Branch;
- Section V: Telecommunications and Electronics Branch.

The Department of Transport trusts that the data and information contained herein will prove to be of value in assisting the Committee in the performance of this worthwhile undertaking.

SECTION I

Submission of the

MARINE HYDRAULICS BRANCH

Department of Transport

to the
Senate Committee on Science Policy

1968

MARINE HYDRAULICS BRANCH

BRIEF ON SCIENTIFIC RESEARCH

The following is a general outline of the major "scientific activities" in which the Branch is involved and is presented in the order set out in the specific guidance supplied.

2.1 Organization

The attached block diagram shows the present organizational structure of Marine Hydraulics Branch. Those divisions and sections conducting or funding scientific activities are identified accordingly.

For the purpose of this survey the units within Marine Hydraulics Branch responsible for, and associated with scientific activities are:

a) Hydraulics Studies Division

b) Engineering Field Investigations Section - St. Lawrence Ship Channel Division

2.2 Organizational Functions

Hydraulics Research and Development conducted by Hydraulics Studies Division fulfills a headquarters role in carrying out and integrating studies and research related to navigation requirements in waterways where the Department of Transport has responsibilities.

Operational effectiveness, duties and goals are reviewed and revised through the Marine Services planning process. Five year program reviews are submitted to department headquarters for consideration and subsequently presented to Treasury Board for approval.

2.4 Distribution of Activities

The primary objective of the Hydraulics Research and Development activity is to provide the necessary technical and hydraulic engineering capability in the total Marine Services Program. The activity is concentrated mainly in the Great Lakes-St. Lawrence River region with particular emphasis on the river reach below Montreal.

Scientific activities performed during the last five years related to investigation of regional problems and phenomena include detailed research and development of navigation facilities through the use of hydraulic and mathematical models; studies of ice problems

and methods of overcoming them; the behaviour of vessels in confined channels; use of physical and mathematical models to study tidal propagation and effects of proposed marine projects on the tide.

2.5 Personnel Associated with Scientific Activities

a) Executive - 1

Scientific & Professional - 4

Technical - 3

Admin. Support - 2

10

The above personnel establishment includes Marine Hydraulics Branch H.Q.

b) Two

c)

	Country of Birth	Secondary & University Education	Years Service Graduation	Average Age	% Able to Operate in Both Languages
Bachelor	3 - U.K. 1 - Canada	3 - U.K. 1 - Canada	21, 18, 11 19	41	40
Master	1 - Canada	1 - Canada	17		
Doctorate	-	-	-	-	-

Professional Staff

		Bachelor	Master	
d)	1963	2	1	
	1964	3	1	
	1965	3	1	
	1966	4	1	
	1967	4	1	
	1968	4	1	
	1969	5	1	
	1970	5	1	Estimated
	1971	5	1	
	1972	5	1	
	1973	5	1	

e) 1965 - 33% turnover in bachelor category.

f) Since Graduation - Employed by

i) Industry 20%

iii) Provincial Govt. 20%

iv) Other Federal agencies 60%

g) Nil

h) Nil

2.6 Expenditures Associated with Scientific Activities

Thousands of Dollars

	Functions	1962	1963	1964	1965	1966	1967
a),1)	Intramural R & D -- Average $400 per year ---------						402*
		1968	1969	1970	1971	1972	1973
		533	512	545	552	459	466

* Plus $1.2 million Capital Cost for construction of NRC laboratory

Scientific Disipline - Engineering & Technology

Area of Application - Marine Transportation

b) As indicated in a) 1) above

2.7 Research Policies

1-2 Hydraulics Studies Division provides a Headquarters focal point regarding the improvement and future development of navigable rivers and waterways that fall within Departmental areas of responsibility, specifically related to matters concerning hydraulics engineering (involving fluvial and tidal hydraulics), engineering hydrology soils physics and water resources development. The Division initiates, carries out and/or integrates all hydraulic engineering and research studies, including those undertaken by NRC and other government agencies or consultants on behalf or in conjunction with the Department. These studies include the construction and operation of large hydraulic models of the St. Lawrence River.

The selection, priority, and initiation of programs and projects are governed by the need to conduct engineering research on improving navigation facilities to ensure their orderly development for safe marine transportation, and to meet the growing demand of commercial shipping

3. Network methods have had limited application in the planning and monitoring of programs and projects to date, but it

is anticipated that this approach will be developed to suit the particular requirements of future studies. A major tool in research and development in the hydraulic engineering field, is the hydraulic model and this is used extensively in these studies.

4. Model studies conducted by the Department are generally contracted out to a commercial hydraulic laboratory or arranged under agreement with other government agencies such as National Research Council, e.g. a contract since 1962 with Lasalle Hydraulic Laboratory for the construction and operation of an hydraulic model of the St. Lawrence River from Montreal to Becancour (an 88 mile reach. Agreement with NRC to construct and operate a large pilot model of the St. Lawrence from Montreal to the sea for the purpose of conducting research into tidal phenomena. (Funds amounting to $1.84 million for this work are being provided by the Department over a five year period.)

5. Numerical techniques, using large digital computers are being used by NRC in conjunction with the physical model to study the complex estuarine problems in the St. Lawrence. The mathematical model complements and operates concurrently with the hydraulic model. No funding is presently arranged for extramural research programs in university and industry.

6. There has so far been no need for shifts of research resources.

7. Research results are generally prepared in the form of formal reports analysis of which generally lead to decisions and recommendations regarding improvements to navigation facilities or modifications to operating procedures.

2.8 Research Output

1) Nil

2) Several journal articles dealing with navigation improvement programs and engineering research activities.

3) Reports prepared are generally for issue within the Department or restricted to other government

agencies, e.g. reports on feasibility studies and hydraulic model test programs.

4) Several papers presented at technical conferences.

8) Valuable research tools and facilities used are hydraulic river models and hydraulic laboratory facilities.

2.9 Projects

1) During the period 1962 to 1967 the following projects were conducted:

i) Champlain Waterway Feasibility Studies.

ii) A study of Methods of Improving Water Depths in the St. Lawrence Ship Channel.

iii) A preliminary Study of Methods to permit Winter Navigation in the St. Lawrence River below Montreal.

iv) Studies relating to the Behaviour of Ships in Restricted Channels (continuing).

v) The use of Experimental Ice Booms for ice control in the St. Lawrence River (continuing).

vi) Study of Tidal phenomena and Estuarine flow - St. Lawrence River - in conjunction with NRC (continuing).

vii) Study of use of radioactive tracers in sediment transportation.

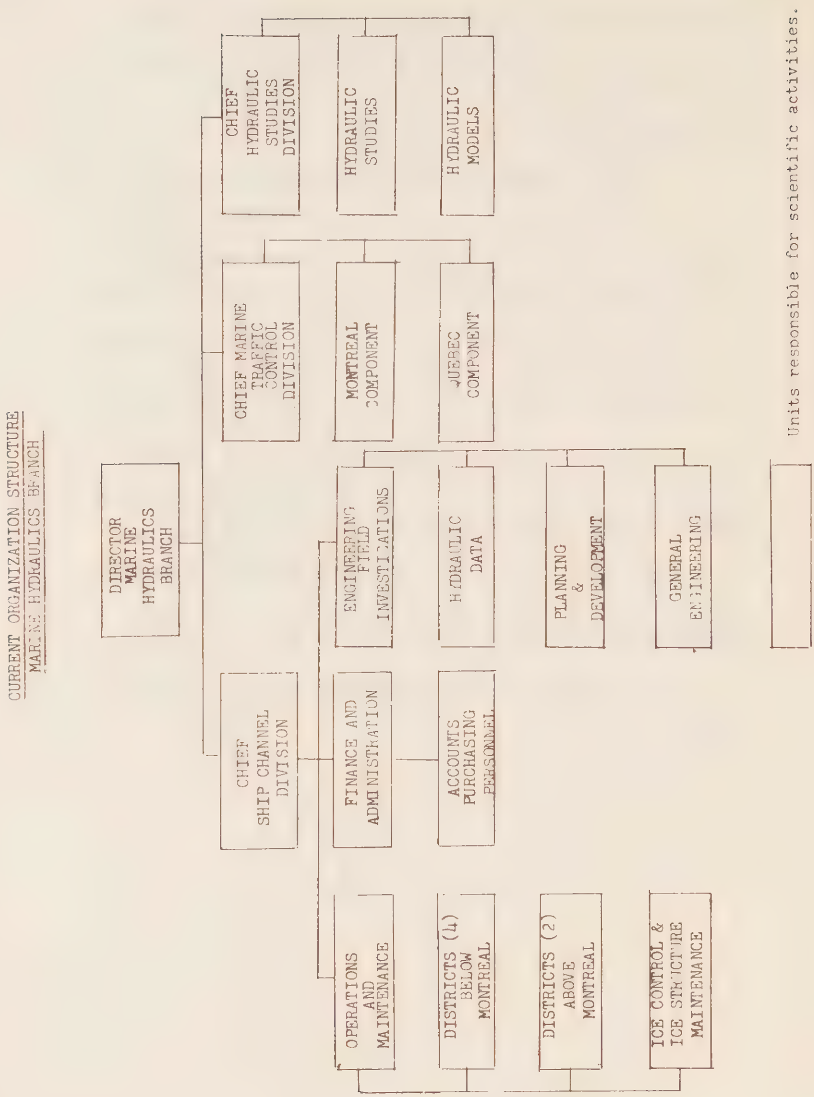
viii) Great Lakes Levels Regulation Studies (continuing).

2. Study of methods of improving water depths in the St. Lawrence Ship Channel may be taken as an example of an important contribution in the field of applied research and development. This study was undertaken to determine the engineering feasibility, hydraulic effects, estimated costs and economic benefits of alternative methods of providing a 39 ft. deep 800 foot wide navigation channel in the St. Lawrence River between Montreal and Quebec. Of the various methods considered it was concluded that the most satisfactory and most economic method of gaining the additional depth would be by further dredging, as opposed to various

types of control works. It was also concluded that the time was not yet appropriate to provide a greater depth than the existing 35 feet.

Experimental Ice Booms

Floating wooden ice booms have been used successfully for a number of years by the power entities to assist in the formation of stable ice covers for hydro-electric power development in the St. Lawrence River. Continuing experiments are being carried out to establish the effectiveness of such structures in controlling ice formation and movement in the St. Lawrence Ship Channel and reducing the work of the icebreakers and the danger of flooding due to ice jams. After one season of operation it has been concluded that the ice booms do materially assist in control of ice, depending on their location and configuration. Should the use of floating ice booms prove practicable as an ice control measure, consideration will be given to their installation in other sections of the St. Lawrence River. This project is a further example of applied research and development aimed at overcoming operational problems in the St. Lawrence River.


CURRENT ORGANIZATION STRUCTURE
MARINE HYDRAULICS BRANCH
DIRECTOR MARINE HYDRAULICS BRANCH
CHIEF HYDRAULIC STUDIES DIVISION
HYDRAULIC STUDIES
HYDRAULIC MODELS
CHIEF MARINE TRAFFIC CONTROL DIVISION
MONTREAL COMPONENT
QUEBEC COMPONENT
CHIEF SHIP CHANNEL DIVISION
ENGINEERING FIELD INVESTIGATIONS
HYDRAULIC DATA
PLANNING & DEVELOPMENT
GENERAL ENGINEERING
FINANCE AND ADMINISTRATION
ACCOUNTS PURCHASING PERSONNEL
OPERATIONS AND MAINTENANCE
DISTRICTS (4) BELOW MONTREAL
DISTRICTS (2) ABOVE MONTREAL
ICE CONTROL & ICE STRUCTURE MAINTENANCE
Units responsible for scientific activities.

SECTION II

Submission of the

ST. LAWRENCE SHIP CHANNEL DIVISION

MARINE HYDRAULICS BRANCH

Department of Transport

to the

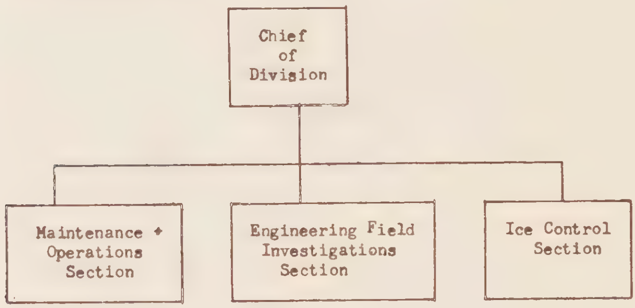
Senate Committee on Science Policy

1968

ST. LAWRENCE SHIP CHANNEL DIVISION

1. (Page 4, item 2.1. (a))

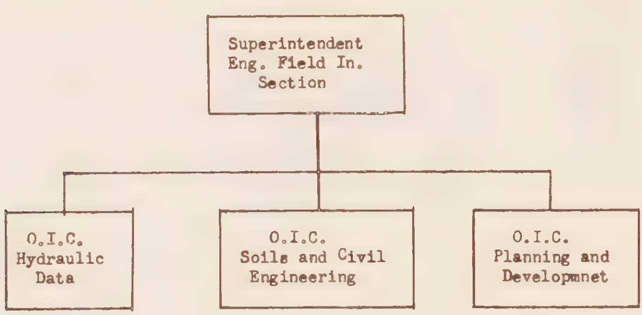
MAIN UNITS CONDUCTING OR FUNDING SCIENTIFIC ACTIVITIES



NOTE: The Engineering Field Investigations Section is the one most responsible for the scientific activities of the Division. However, some data is also collected, compiled, and analysed by the other two sections shown, mainly as part of their operations. Combined programs are run with the E.F.I. Section providing a service to the other two Sections.

2. (ref. page 4, item 2.1. (c))

BLOCK DIAGRAM INDICATING ORGANIZATION OF E.F.I. SECTION



3. (ref. page 4, item 2.2. (a))

The functions of the Ship Channel that might properly be related to scientific activities are to improve and maintain the main river ship channels from Lake Ontario to the Gulf of St. Lawrence; to assess

the present and future requirements of shipping and to plan the attainment of maximum navigation benefits, particularly relative to safety and efficiency; to collect and correlate basic engineering data for the study of improvement projects; to minimize flooding due to ice formation.

4. (ref. page 5, item 2.2. (b))

Ship Channel Committees of the 1950's recommended the establishment of permanent hydraulic engineering organizations attached to the Ship Channel work. Personnel have been absorbed in 1959 from Seaway work and a nucleus of hydraulic engineering competence established which grew into the Branch proportions of the present day.

5. (ref. page 5, item 2.2. (c))

The organization's functions and responsibilities in relation to:

(i)	other federal agencies: National Harbours Board, St. Lawrence Seaway Authority, Public Works Department National Research Council, Department of Energy, Mines & Resources	- study of the effects on downstream St. Lawrence reaches of Great Lakes regulation; tidal studies of the St. Lawrence, Montreal to Father Point.
(ii)	Industry:	- provide river regimen data to consulting engineers and shipping firms to be used in their planning and development work. E.g. flood water level records were divulged for the planning of the Nun's Island housing development.
(iii)	educational facilities:	- provide floating equipment use in parallel with our programs, for the collection of field data. E.G. salinity

sampling for thesis studies at Ecole Polytechnique, Montreal.

(iv) international: - attendance at conferences of the International Association for Hydraulic Research.

6. (ref. page 5, item 2.2. (d))

Five-year program reviews are submitted in January of each year. The next year's program is reviewed in detail and estimates are drawn up in August of each year. Project memoranda are written to give the justification. Staff meetings are held to review progress. Deadlines are set for feasibility report issue dates.

7. (ref. page 5, item 2.2. (e))

Department of Transport, Management Services Branch, Report on "Organization Study, District Level, Ship Channel Division", July 7th, 1967, by Mr. H. Young.

8. (ref. page 5, item 2.3. (a))

Every summer about ten engineering undergraduates are hired as casuals to work on the compilation and initial correlation of hydraulic data. Out of these, we hope to engender in some an interest in our work, such that they may be invited to join our permanent staff on graduation. In addition to this, we submit requests for one Bachelor level graduate from a Canadian University in the Applied Science Program specializing in Civil Engineering with a preference for hydraulic engineering aptitude.

9. (ref. page 6, item 2.4. (a))

The activities of the Division are restricted to the provinces of Quebec and Ontario, more specifically from the foot of Lake Ontario to the Gulf of St. Lawrence.

10. (ref. page 6, item 2.4. (c))

1. Feasibility studies of projects to deepen the St. Lawrence Ship Channel between Montreal and Quebec from 35' to 39'.
2. Engineering and economic studies of proposal to deepen the

channel below Quebec to 45'.

3. Studies of ice formation for the prevention of floods.

4. Ship behaviour studies to determine channel depth design criteria.

11. (ref. page 6, item 2.4. (d))

The St. Lawrence Ship Channel is the core facility responsible for the operation, maintenance and improvement of the 35' deep shipping lane to Montreal, as well as the shallower interconnecting non-canal reaches above Montreal to Lake Ontario. The Development of the whole St. Lawrence region is undeniably connected to this marine transportation artery linking the sea to Canada's largest port. Other harbours, notably Quebec and Trois-Rivieres benefit similarly and reflect their attachment to the St. Lawrence in their own regional development.

12. (ref. page 7, item 2.5. (a))

1. Engineering Field Investigations Superintendent Office: 1 engineer, 1 steno.

2. Hydraulic Data Unit: 2 engineers, 7 technical officers, 2 technicians, 1 draftsman, 5 captains, 5 mechanics, 13 seamen, 8 students, 15 casuals.

3. Soils and Civil Engineering Unit: 2 engineers, 2 students, 1 casual.

4. Planning and Development Unit: 2 engineers, 1 technical officer, 2 draftsmen.

13. (ref. page 7, item 2.5. (b))

Superintendent of Engineering Field Investigations Section.

14. (ref. page 7, item 2.5. (c))

	BACHELOR	MASTER
i) Country of Birth:	4 Canada, 1 France	1 Canada 1 Vietnam
ii) Country in which secondary education taken	4 Canada, 1 France	1 Canada 1 Vietnam
iii) Country in which university degree taken (bachelor, master, doctorate)	4 Canada, 1 France	2 Canada

	BACHELOR	MASTER
iv) Number of working years since graduation.	18, 15, 10, 5, 12	11, 2
Number of years employed in present organization.	2, 7, 2, 2, 2	3, 1
v) Average age	36	30
vi) Percentage able to operate effectively in Canada's two official languages.	100%	100%

15. (ref. page 7, item 2.5. (d))

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	72	73
BACHELOR	3	3	3	3	5	5	5	5	6	6	6	6
MASTER	0	0	0	0	0	1	2	2	2	3	3	3

16. (ref. page 7, item 2.5. (e))

Turnover

	1962	1963	1964	1965	1966	1967
BACHELOR	0	1	0	1	0	0
MASTER	0	0	0	0	0	0

17. (ref. page 7, item 2.5 (f))

i) 70% have been employed by industry at one time

ii) 15% have been on staff of universities

iii) 30% provincial departments or agencies

iv) 30% other Federal agencies

18. (ref. page 7, item 2.5 (g))

1 Bachelor on education leave.

19. (ref. page 8, item 2.5 (h))

	1962	1963	1964	1965	1966	1967
Student summer employment.	0	0	7	6	6	8

20. (ref. page 8, item 2.6 (a))

In Thousands of $

Functions FY	1962 1963	1963 1964	1964 1965	1965 1966	1966 1967	1967 1968	1968 1969	1969 1970	1970 1971	1971 1972	1972 1973	1973 1974
1) Intramural R&D	8.9	9.4	39.7	37.5	29.0	109.0	261.4	207.3	260	275	290	290
2) Data Collection	345.7	460.1	685.8	620.1	629.1	543.3	715.8	765	529	527	529	530
Scientific Discipline:												
1) Engineering and technology	354.6	469.5	725.5	657.6	658.1	652.3	977.2	972.3	789	802	819	820
Areas of application:												
6) Transportation	354.6	469.5	725.5	657.6	658.1	652.3	977.2	972.3	789	802	819	820

21. (ref. page 8, item 2.6 (b))

1) <u>Operating funds</u>												
Supt. E.F.I.	8.9	9.4	9.7	10.2	10.5	18.1	18.5	58.3	50	55	60	60
Hydraulic data	253.7	345.1	527.8	493.1	416.1	434.3	596.8	495.0	500	505	510	510
Soils and civil engineering	-	-	30.0	27.3	18.5	21.9	109.6	86.0	100	105	110	110
Planning and Development	-	-	-	-	-	69.0	133.3	63.0	110	115	120	120
TOTALS	2626	354.5	567.5	530.6	445.1	543.3	858.2	702.3	760	780	800	800
2) <u>Capital funds</u>												
Supt. E.F.I.	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic data	92	115	158	127	213	109	119	270	29	22	19	20
Soils and civil engineering		-	-	-	-	-		9	10	15	15	15
Planning and Development		-	-	-	-	-		25	30	30	25	25
TOTALS								304	69	67	59	60

21. (ref. page 9, item 2.7 (a))

1. Other Federal agencies, such as the NRC, belong to interdepartmental committees responsible for long term hydraulic model research.

2. Priorities are established on the basis of safety to navigation first, with optimization of facility use following.

3. Critical Path Networks have been used to monitor programs of field data collection over a span of a season. Adaptions of CPN and PERT have been used to monitor channel sweeping schedules.

4. Contracts have been made as follows:

   i) With professor of soils mechanics, University of Montreal, as a consultant on the preliminary design of dykes and the final design and construction of artificial islands on Lake St. Peter.

   ii) Consulting engineers have been employed to carry out soil sampling, rock borings, and seismic work.

   iii) Consultants have been used in the preliminary design of river regulatory work schemes.

5. Extramural research programs are not carried out in universities or industry.

6. No shifts of research resources have been made.

7. Improvements to the Ship Channel are documented on charts and described on notices given to the shipping companies, masters of ships, pilots.

22. (ref. page 11, item 2.8)

1. Nil

2. i) Engineering Institute of Canada Journal January 1965 paper entitled "The Development of the St. Lawrence Ship Channel" by H.L. Land and J. Sylvester delivered at the 78th Annual General Meeting, Banff, Alberta, May 27-29, 1964.

ii) The Society of Naval Architects and Marine Engineers paper by H.L. Land "Living with a River". Meeting, Montreal, April 23, 1963.

3. Basic Data Inventory, Shore Property Investigation St. Lawrence River, Montreal to Trois-Rivieres, Montreal, April, 1968.

4. Attendance at conferences of the International Association for Hydraulic Research held once every two years.

5. Nil.

6. Mr. G. Charette, employed as a unit head, later went with a United Nations team on a hydrologic survey in Somalia, Africa.

7. Trained data collecting units have been formed having unique abilities in the collection of water levels and velocities in tidal estuary work as well and non-tidal upland reaches of the St. Lawrence. Back-up office staff to compile, correlate, and analyse the data have been formed using up-to-date computer techniques.

8. Oceanographic antonomous metering devices have been adapted to estuary and river tidal observations. English, German, and French designed meters have been employed in high velocity waters hitherto unmetered. Instruments used normally in low velocity ocean currents have been adopted for our use.

23. (ref. page 12, item 2.9)

a) Hydraulic Data Unit: Over the period from 1962 to 1967 inclusive, this Unit has been carrying out the field data collection, compilation, and correlation along the entire reach of the St. Lawrence river including tital and non-tidal sections. Data includes: (a) river flow measurement for total cross-sections and river arms in the non-tidal areas as well as one 24 and 48 hour continuous measurements in tide cycles; (b) water level gauging both by staff and automatic continuous water level recorders (c) wind velocities (d) surface current directions and magnitudes (e) salinity (f) sedimentation, (g) water quality (h) ice thickness and formation (i) water temperature.

Most of these data form the input to physical and mathematical hydraulic model testing which is being carried out continuously.

b) Soils and Civil Engineering Unit: Which prepares and updates the complete inventory of soil and rock information in the St. Lawrence River. This includes the basic geology description and a compilation of about 5 million worth of borings and soil sampling. The unit also prepares specifications for soil exploration and supervises the program. About $300,000 has been spent on borings in the last three years in the Lake St. Peter and upstream reach alone. Measurements of scour and erosion are taken. Preliminary design of dykes and control works are carried out. Ship maneuverability measurements and under keel clearances are observed in the development of channel depth and width design criteria. Ship generated wave effects on ice covers are measured.

c) Planning and Development Unit: Input to hydraulic models is prepared. Test series are initiated and participation in model tests is maintained. Results of tests are evaluated. Surveillance of the effects of Lake Ontario Regulation is carried out on a continuous basis with water levels from critical gauging sites telemetered instantaneously to the office. Basic data compiled and methodology developed for the evaluation of the effects of the regulation of all the Great Lakes. Design of ice abatement works. Computer analysis for substantiation of percent of time availability of tidal depths for shipping.

24. (ref. page 13, item 2.10)

1. The St. Lawrence Ship Channel's operations, functions, and responsibilities during the next 5 to 10 years will tend to grow in parallel with the continuing trend towards larger deeper draft vessels.

2. Faster and more reliable machine methods will be introduced on board the floating equipment and new instruments will be used to improve the Ship Channel's effectiveness.

SECTION III

Submission of the

METEOROLOGICAL BRANCH

Department of Transport

to the

Senate Committee on Science Policy

1968

METEOROLOGICAL BRANCH - DEPARTMENT OF TRANSPORT - CANADA

Report to Senate Committee on Scientific Policy

1. As a scientific service with strong ties in national and international science the Meteorological Branch is deeply interested in the studies of the Senate Committee on Scientific Policy. After a review of the Order of Reference of the Committee, the Branch feels it has something to say on each of its terms. These statements are given below. The letters a - d correspond to the terms of the Order of Reference in order that the statements may more easily be related to them.

(a) Recent Trends in Research & Development Expenditures in Canada as Compared with those in other Industrialized Countries:

Accurate figures on the total expenditures for Research & Development in Meteorology in other countries, or even in Canada, are not readily available. Even when they can be obtained, they should be treated with caution since the methods of allocation of costs are unknown and are almost certain to vary from one country or from one agency to the other.

In searching for expenditure trends in research and development, the United States of America was the only government that indicated specifically the total expenditure. Canadian figures are available for the Meteorological Branch, Department of Transport, but not available for other Canadian agencies, such as universities, for periods of several years.

Special Study #2 "Physics in Canada" commissioned by the Science Secretariat, indicates that in 1967, about $5 million dollars were expended annually on meteorological research in Canada, as compared to approximately $278 million expended in the U.S.A. This gives an indication of the magnitude but not the trends.

Appendix 1 gives a tabulation of the expenditure figures for the Meteorological Branch, for the period fiscal year 1964-65 to 1968-69 and figures on U.S. Government expenditures for the period

1966 to 1969 (estimated). Over the same period 1966-69 (est) the Canadian expenditure rose 59.1% from a very small base, while the U.S. expenditure rose 25.8% from a very much larger base. There is a definite decreasing trend in the percentage increase in Canadian expenditures. The U.S. trend shows a marked irregularity due in the main part to a large upsurge in space research on behalf of meteorology in 1968. In the overall, there has been a continuing expansion in meteorological research in the U.S.A. There is no reason to believe that this rate of increase will not continue in the U.S.A. where a much higher proportion of the Gross National Product is spent on research and development than in any other western nation.

(b) Research and Development in the Meteorological Branch

1. Introduction

One of the characteristics of meteorological research is that the information and understanding obtained is seldom very far removed from having economic significance, often of great importance. Thus, the separation in this field between pure and applied research is often not aimed directly at supporting a particular, practical activity generally in response to stated requirements will be defined as applied. However, almost all the research can be readily related to anticipated practical benefits.

2. Applied Research

2.1 In support of the Forecast System

The Canadian Forecast System provides routine and special weather forecasts for a wide variety of users (the general Public, aviation, construction, agriculture, transportation, etc.). A large number of weather elements are forecast and are important both for general activities and special operations as well as for health and safety.

2.1.1. Techniques for providing improved forecasts for a large number of weather elements or for forecasting new elements are con-

tinuously being developed. Sometimes the techniques deal with the forecast parameter directly and sometimes they concern improvement in the prediction of intermediate processes or parameters necessary for the final prediction schemes. Following are some of the elements which are studied: examples of the users in addition to the general public are given in brackets:

(a) precipitation amounts and intensities and their distribution in time and space (flood hazards, agricultural operations, transportation, snow removal, forest-fire control, water resources control, etc.);

(b) clouds, fog and visibility (aviation, transportation, agriculture, etc);

(c) wind strength and direction (aviation, construction, crop spraying and drying, forest fire control, marine activities, rocket firings, etc.);

(d) severe storms including thunderstorms, hail, hurricanes, tornadoes, very strong winds (emergency health and safety authorities, construction, crop protection, marine, etc.);

(e) temperature and humidity including extreme high and low temperatures and soil temperatures (health authorities, transportation, agriculture including sowing, harvesting, crop protection, snow melting and flood control, freezing and melting of lakes and rivers as related to water transportation, heating and air-conditioning industries, etc.);

(f) aircraft flight conditions including turbulence and icing (aviation).

2.1.2 Research is being carried out to develop a system for automated short-range aviation forecasting to meet the needs of aviation for up-to-the-minute accurate information.

2.1.3 Research and development is proceeding on the reception and use of radar and weather satellite observations for weather forecasting. These are becoming major tools in the observation and prediction of weather.

2.1.4 The Central Analysis Office of the Meteorological Branch provides basic prognostic information used by the Forecast Offices

across the country to prepare their forecasts. These prognoses are carried out using a large computer, and research and development studies to improve the models and methods in use is a continuing activity. Although initially confined to the forecasting of flow patterns studies are going forward to extend this to forecasting weather elements, e.g. precipitation.

2.1.5 The observation system of the Meteorological Branch includes hundreds of stations which carry out routine observations for transmission by special weather circuits as basic information nationally and internationally for use in weather prediction. A continuing program to improve and develop methods of observing weather elements and other meteorological parameters is carried out. This includes

(a) development of improved instrumentation for measuring such elements as winds, temperature, humidity, cloud heights, visibility, precipitation,

(b) development of automatic weather stations to measure and transmit unattended the standard weather elements,

(c) studies to improve the rawinsonde network (stations which routinely measure meteorological parameters up to 100,000 ft by balloon ascents) both in regards to instrumentation and techniques to extract the appropriate information,

(d) development of special instruments or instrument design for a wide variety of conditions and special observational programs (Canadian Arctic, Ocean Weather Ships, tall towers, locations difficult of access, etc.).

2.2 In Support of Various Users

Routine and special forecasts as described in 2.1 are available for periods up to three days for a variety of purposes. However, other studies are carried out to improve operations and assist with planning by providing suitably-processed climatological information and a better understanding of the mechanisms whereby weather-sensitive activities are influenced by weather and climate

2.2.1. Agriculture and Forestry

The selection and improvement of crops and the design of optimum operational procedures are benefitted by studies dealing with

(a) climate information on temperature, humidity, percipitation drought, frost, hail, wind as it influences structures and shelter belts, etc.;

(b) energy and moisture balance of crops and forest stands,

(c) formation of dew,

(d) relationship of frost to topography,

(e) design of instruments and techniques for bioclimatological studies

2.2.2. Water Resources

The use and control of water resources is of course, greatly influenced by weather parameters such as percipitation, temperature, wind, etc., and an improved understanding of the mechanisms can result in great economic benefits. Problems studied of this kind include:

(a) design of spillways, and river control structures as related to normal and extreme rainfall and snowmelt,

(b) design of water supply and irrigation systems as influenced by precipitation and evaporation,

(c) flood and river control forecast methodology,

(d) terrestrial and atmospheric water balance as related to watersheds,

(e) relationship between wind, temperature, etc. and waves, currents, seiches, ice formation, ice melt in lakes and rivers,

(f) relationship between lake levels and precipitation and evaporation,

(g) areal variation of precipitation as related to topography.

2.2.3. Transportation, Communications, Construction, Industry

A large number of activities relating to the industrial and economic life of the country are influenced by weather, and relevant

problems are studied including:

(a) ice accretion on towers, buildings, power lines, antennae, etc.,

(b) winds and the design of structures such as bridges, tall buildings, etc.,

(c) weathering of materials,

(d) factory, airport, and town site selection as influenced by weather,

(e) construction weather probabilities for planning,

(f) occurrence of permafrost,

(g) wind wave relationships for determination of shipping regulations and ship design,

(h) ice in navigable waters as related to shipping,

(i) weather influences on radio communication,

(j) climatic influences on arctic oil and mining exploration and operations

2.2.4. Air Pollution Control

The Meteorological Branch provides advice and assistance from a meteorological point of view to other government agencies in Canada and to industry on air pollution problems. These are of great increasing importance with respect to the health of the population as well as having various economic aspects. Topics under continuing study include:

(a) the design and location of factory and factory complexes in respect to noxious effluents especially in oil, chemical and mining industries,

(b) the control of radioactive exhaust gases from nuclear power plants,

(c) the occurrence of hazardous air-pollutant concentrations in urban areas and over larger regions as a function of meteorological conditions,

(d) the influence and control of automative exhaust gases.

2.2.5. Aviation

The design and operation of aircraft and associated aviation systems is strongly influenced by meteorological parameters. Both from a point of view of safety and efficiency it is necessary to understand in great detail the complex interactions between aircraft flight and its atmospheric environment. An aeronautical meteorology research program is being carried out involving studies such as:

(a) aircraft turbulence and mountain waves in respect to forecast techniques and design and operational implications,

(b) wind regimes around airports in connection with the takeoff and landings of aircraft and with the design of automatic landing systems,

(c) aircraft hazards such as icing, hail, electricity, etc.,

(d) the influence of low-level winds on special vehicles, e.g. vertical takeoff vehicles, rockets, very large aircraft, etc.,

(e) the time and space variability of low clouds and visibilities around airports.

3. Research into Atmospheric Dynamics and Circulations

3.1. Dynamic Meteorology

Great progress has been made in theoretical meteorology using the basic dynamic and thermodynamic equations in conjunction with very large computers. As indicated in 2.1 this has resulted in routine operational procedures plus applied research to back them up. More basic research along the same lines will permit better understanding of atmospheric processes resulting in more accurate and longer forecasts. Topics studied include:

(a) energetics of atmospheric circulations,

(b) modes of development in extra-tropical cyclones,

(c) influence of moisture exchanges on the synoptic circulations,

(d) new physical and mathematical models for studying and forecasting circulation patterns.

3.2. Micrometeorology

Micrometeorology involves studies of atmospheric processes on a scale from a few inches to about a mile. These include processes of importance in a number of fields including air pollution, agriculture, forestry, urban planning, etc. In addition, these processes involve the loss of energy due to turbulent interaction of the atmosphere with the earth and, therefore, are significant in atmospheric dynamics. Some of the topics studied are as follows:

(a) wind and turbulence in the surface boundary layer,

(b) turbulent flux of heat, momentum and particulate matter,

(c) variability of momentum flux in the earth's boundary layer,

(d) effect of turbulence on coherent and incoherent light propagation in the atmosphere,

(e) temperature and humidity microstructure at a land-lake interface,

(f) techniques for measuring turbulence, wind and humidity on a micro-scale.

3.3 Mesometeorology

Mesometeorology refers to a scale of atmospheric motions ranging from about one mile horizontally up to about 100 miles and includes processes of great importance in local weather variability. Thus, studies such as the following are of basic importance for a number of purposes including aviation terminal forecasting, air pollution control, urban planning, agriculture, etc.:

(a) Use of meso-networks for aviation terminal forecasting,

(b) meso-scale circulations as related to local terrain including lake-breezes, valley winds, gravity waves, etc.,

(c) thunderstorm and hail-storm dynamics,

(d) energy and momentum exchanges between meso and larger scale circulations as related to large-scale dynamics.

4. Physical Processes in the Atmosphere

4.1. Cloud and Precipitation Physics

Studies on the cloud and precipitation processes in the atmos-

phere may have very large economic consequences. This, in part, results from the fact that it may be feasible to modify and, to a certain extent, control these processes and, thus, influence the amount or type of precipitation falling over a given area. Both fundamental studies and cloud seeding trials are necessary for this purpose and the following are some of the problems being investigated:

(a) mechanisms of rain, cloud and hail formation and methods to modify these mechanisms,

(b) cloud-seeding trials and their evaluation,

(c) dispersal of fog at airports,

(d) condensation nuclei and ice-crystal formation,

(e) use of radar to study and measure cloud and rain,

(f) detection and tracking of lightning and lightning storms for forest-fire control,

(g) measurement of atmospheric electrical fields including conductivity and ion current density and their relationship with other meteorological parameters.

4.2 Radiation

The study of radiation, both solar and terrestrial, is of fundamental importance in respect to atmospheric energetics. In addition, information on radiation is of importance in a large number of human activities including agriculture, construction, health, etc. Research and development programs on this topic include:

(a) basic properties of radiation instrumentation and their design and standardization by international intercomparisons,

(b) development and use of radiometersondes for measuring radiational variation with height in the atmosphere,

(c) use of radiation data for a number of applications including atmospheric dynamics, agriculture, construction, etc.

5. Upper Atmosphere Research

The atmosphere above 30 km contains only about one percent of the earth's atmosphere but the nature and extent of the interactions, both physical and dynamical between this region and the underlying atmos-

phere requires examination. The coupling mechanisms, through circulation and radiative processes require study both from the viewpoint of downward energy propagation and climatic modification, and upward in relation to radio communications and flight through these regions (rockets, advanced vehicles). Studies include:

(a) The use of a meteorological rocket network to sound the atmosphere routinely from 30 to 60 km and eventually 90 km,

(b) the measurement of ozone in the atmosphere both from ground-based systems and by use of ozonesondes,

(c) analysis of ozone data and radioactive tracers to establish circulation patterns,

(d) development and operation of a noctilucent cloud observational network and analysis of the data to provide information on circulations and processes at these levels,

(e) development and operation of air-glow stations to use these emissions at upper-atmospheric levels as indicators of circulations,

(f) development of meteor-trail Doppler radar techniques for use in measuring winds and motions in the 80-110 km range,

(g) theoretical studies of radiational processes in the upper atmosphere and their influence on circulations at these levels.

6. Other Investigations

Various studies are carried out to improve procedures and methodology in a number of Meteorological Branch activities. These include studies to optimize data archiving, computer use, meteorological communications, weather dissemination, etc.

. . . .

(c) Federal Assistance to Research and Development Activities Carried out by Individuals, Universities, Industry and Other Groups

The Meteorological Branch supports research in meteorology at Canadian universities through a grants-in-aid programme, similar and comparable with that of NRC. These funds are given to individuals at the universities to undertake research in the atmospheric sciences proposed by the researcher, acceptable to the Director of the Meteorological Branch.

There are also contracts to undertake studies for the Meteorological Branch, in those areas where the Branch requires the studies for the advancement of specific knowledge.

The expenditures in these categories for the last five years are listed in Appendix 2.

. . . .

(d) Principles of Science Policy in Meteorology

Science policy should lead to action. The aim should be to anticipate Canada's future needs for both scientists and scientific results and to ensure they are ready when the economy is ready for them. Ideally science policy should lead to action resulting in a future array of scientific personnel and scientific results appropriate to the scientific needs of the economy of that time.

Canada's goals might be considered as lying in the areas of economic growth and productivity, resource development and management, human amenities, human intellectual and recreational activity. All of these areas now depend on science. For this reason part of the science policy should aim at greater participation of scientists in the establishment of national goals.

Science policy should manifest itself in the supply of a sufficient flow of resources into the scientific organizations to ensure adequate support for Canada's future economic development. These organizations can be classified as (1) Government (federal) (2) University

(3) Industry (4) Societies (5) Other (including provincial and private organizations). As a first step in considering science policy the place and importance of these institutions should be mentioned. Briefly these are:

Government - Development of policy, e.g. for science growth and application, support of science and scientists, methods of support, retraining due to obsolescent skills; control legislation; co-ordination among scientific agencies; financial and other support of societies, national and international organizations and programs, universities, professors, etc.; scientific services; applied research and development; basic research in areas inadequately covered by other agencies; internal scientific training; provision of advice on the state of science.

University - Interest-oriented basic and applied research; scientific consultation; participation in research of other agencies through contract; education, and hence supply, of all scientists.

Industry - Product-oriented R&D; financial support to universities and non-profit research agencies; research under contract.

Societies - Custodians of scientific and professional ethics and standards; editorial and publication services; often generate and recommend on scientific policy.

Other - Mostly specialized services or research; R&D in support of local industry.

Meteorology, the science of the atmosphere, affects all parts of the economy, all areas of the country, and indeed well beyond. Management of its own vast resources is of major concern to Canada. Meteorology is basic to resource management in primary endeavours such as agriculture, forestry, mining, fishing, water, and air (pollution). It is basic also to other primary industries such as manufacturing, building, transportation and power. Any policies for development or improvement of these industries requires parallel policies for meteorology. For example, no nuclear power plant may be established without a thorough study of the diffusion characteristics of the atmosphere in that environment; no realistic policy to develop the north could be implemented without extensive meteorological

and climatological studies.

With this background we would propose the following principles be considered as a basis for developing science policy in the field of meteorology:

Economic Link: There should be a federal government agency charged with the responsibility to predict the general trend of demands on the Canadian scientific community, in the field of meteorology in this instance, both for scientific and technological personnel and skills and for scientific product that will be required some years hence. In doing so full use should be made of government policies and plans for economic growth and its scientific implications. Science policy should be of such a nature as to provide a linking of resources for research and the Gross National Product. It should also provide for emphasis to go to achieve the desired scientific growth pattern as required for Canada's development

Production and Services: In the case of meteorology support should be given to the Meteorological Service of Canada to implement plans to provide additional services required by the economic study. Funding would be through normal budgetory procedures To a lesser extent private companies may have a share in providing some specialized services.

Applied Research and Development: Guidelines as to the desirable magnitude of the supporting applied research and development effort should be developed. Most of this, being closely related to the service operations, would come under the management control of government departments and agencies. The guidelines would support the budgetory demands. Government policy might be needed to provide further guidelines for sub-contracting scientific studies to universities and other competent organizations.

Basic Research: Government policy regarding the needs of Canada for basic research might be developed, partially based on the economic study and recognizing the large time-gap between basic discovery and practical application. Since most basic research is done in universities a policy is needed to ensure that the

university scientist population is of high quality and well matched with respect to fields of competence to the future needs of the country. This can be done through policies and procedures aimed at building research programs in areas where interests or support is otherwise insufficient to produce the results the economy will need. Activity can be stimulated, for example, through major development grants. Also since some important fields of basic research are not taken up by the universities government policy should ensure that these are covered within the departments or other agencies.

Education and Training: While education is a provincial matter the federal government must be concerned about the adequacy of Canada's ability to turn out the scientists, technologists, and technicians appropriate to its growth requirements. Policies are needed to encourage the improvement of this capability in deficient areas. Some policies affecting universities and dealt with under research work tend in this direction but others are needed. Major development grants to stimulate research is one approach. Policies encouraging student supply in general, and in particular areas, are valuable here, as for example, through scholarship and fellowship schemes. Policies encouraging co-operation between government scientific organizations and universities are valuable and help both. It is also felt that, for government staff, policies should tend to encourage maximum use of existing educational and training facilities. In-house training should be limited to specialized training appropriate to the job and which could not be properly supplied from outside.

Legislation: One area of action peculiar to government is legislation. In order to avoid undesirable duplication of authority or responsibility legislation may be necessary. The government should ensure that such legislation is developed wherever developing science indicates the need. One such field now beginning to receive attention is weather modification. Legislation may also be used to implement

policies favouring encouragement of R&D in industry as, for example, through tax amelioration.

Appendix 1

August 31, 1968.

RESEARCH AND DEVELOPMENT EXPENDITURES - METEOROLOGICAL BRANCH

	1964-65		1965-66		1966-67		1967-68		Estimated 1968-69	
	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital	O&M	Capital
Operational Development and Evaulation (CAO)	66,000	-	64,100	-	94,500	-	164,100	-	169,000	-
Instrument Engineering & Research	196,056	100,000	233,153	189,640	318,000	102,006	401,617	108,900	508,935	327,500
Atmosphere Research	533,242	143,294	683,050	211,016	814,796	376,019	921,381	416,800	801,000	346,000
Climatology Research - General	111,448	18,531	139,300	40,000	176,367	20,919	210,744	27,400	224,621	189,600)
Climatology Research - Hydrometeorology	78,505	52,000	92,432	94,704	138,620	116,769	201,897	113,400	208,177	)
Scientific Development and Evaluation - (R&T)	44,400	-	48,100	-	50,900	-	76,300	-	78,600	-
	1,029,651	31[illegible],825	1,260,135	535,360	1,593,183	615,713	1,976,039	666,500	1,990,333	863,100
Canadian Meteorological Services	1,343,476		1,795,495		2,208,896		2,642,539		2,853,433	
% Increase			33.6%		23.0%		19.6%		7.9%	
U.S. Government			62,755,000		65,941,000		82,563,000		78,961,000	
% Increase					5.7%		25.2%		(4.2%)	

Appendix 2

August 31, 1968.

METEOROLOGICAL BRANCH HEADQUARTERS

Assistance to Research & Development Activities in the Field of Meteorology carried out by Individuals and Universities

GRANTS		1964-65	1965-66	1966-67	1967-68	Estimated 1968-69
Canadian Universities		94,500	110,000	125,000	155,300	198,300
CONTRACTS						
McGill University	- Hail Research	36,323	45,000	55,000	60,000	63,500
University of Western Ontario	- Studies in the field of Atmospheric Electricity		4,600		25,000	35,000
University of Toronto	- Great Lakes Institute		2,534	10,000	10,326	344
Laval University	- Inst. of Geography - Study of Climate of the Province of Quebec			5,020	10,000	
University of Saskatchewan	- Dense Precipitation Network for Bad Lake				3,250	2,500
University of Windsor	- Average annual water surplus			2,600		
		130,823	162,134	197,620	263,876	299,644

SECTION IV

Submission of the

TRANSPORTATION POLICY AND RESEARCH BRANCH

Department of Transport

to the
Senate Committee on Science Policy

1968

TRANSPORTATION POLICY AND RESEARCH BRANCH

The scientific activities of the Transportation Policy and Research Branch must be considered in the context of its prime role which is the provision of economic and technical opinions to the Deputy Minister and Minister for the ultimate formulation of transportation policy and the preparation of legislation related thereto. The following outline of the relevant activities of the Branch is set out in conformity with the guidelines provided by the Committee:

2.1 ORGANIZATION:

a. An organizational block diagram illustrating the main units of the Branch appears on page 71 below. All six divisions and sections of the Branch are engaged in transportation research, advising on higher level university training required to meet future transportation needs and sponsoring training and research programs directed to this end.

b,c: See organization diagram on page 71.

d,e: Not presently applicable.

2.2 ORGANIZATIONAL FUNCTIONS

(a) The Transportation Policy and Research Branch has no statutory functions and powers regarding scientific activities.

(b) Science Policy: The activities of the Branch are directed towards contributing to the achievement of the most rational and optimum distribution of that portion of the nation's resources allocated to transportation.

2.2 cont'd.

(c) i) The functions and responsibilities of the Branch in relation to other Federal agencies include economic and, to some extent, managerial critiquing of expansion programs or major operational changes, short and long term market forecasts, assessments of the economic and social impact of labor demands, disputes and settlements, appraisals of the acquisition and relinquishment of transportation routes and their relationship to other carriers, the evaluation of Federal, provincial and municipal tax changes affecting transportation costs, the determination of the effects of changes in legislation and regulations, and the co-ordination of scientific research conducted in various areas.

ii) Another aspect of the functions and responsibilities of the Branch involves attempting to assess the extent of Federal assistance or direction that should be afforded industry in the transportation sector. This role is normally in relation to that segment of private industry which lacks the resources or commercial incentive to enter alone a specific field. It sometimes entails evaluations, for example, of whether an industry should be subsidized by the Federal Government or the Government should directly assist in design and development undertakings. This type of work requires the maintenance of continuing surveillance over areas of activity where public support may possibly be required, as in the case of the construction of container port facilities, solids pipelines and branch line railways, and in the field of urban transportation. It should be

2.2 cont'd.

noted that the responsibility for a number of the aforementioned areas may be assumed either in whole or in part by the new Research Division of the Canadian Transport Commission.

iii), iv) The functions and responsibilities of the Branch with reference to educational institutions, international representation and the monitoring of scientific activities outside of Canada entail the maintenance of liaison and information exchange with economic planning and analysis groups, universities interested in transportation research, transportation companies, trade associations and other agencies. In addition, the Branch advises on university training required to meet future transportation needs, sponsors appropriate research programs, and has members of its staff participate at various national and international transportation conferences.

(d) To the extent that change is indicated, certain aspects of the duties and goals of the Branch are reviewed by the Deputy Minister several times monthly while other aspects are discussed with the Management Council (a body consisting of the Deputy Minister of Transport, the Assistant Deputy Ministers Air, Marine and General, and senior administrative departmental heads) as the occasion arises. There is also a liaison and review process in respect of certain areas of research endeavour and the effectiveness thereof, engaged in by the Research Commissioner of the Canadian Transport Commission and the Director of the Branch and their respective superiors, the President of the

2.2 cont'd.

Canadian Transport Commission and the Deputy Minister of Transport. In addition, once annually the programs for the forthcoming year and five year period are reviewed by the Deputy Minister at the time the Treasury Board submission for the next fiscal year, which, in part, deals with goals, duties and staffing, is being made. Also, once a year the corresponding individual goals and responsibilities of the division chiefs of the Branch are thoroughly reviewed.

(e) No outside studies have been commissioned during the past five years to suggest improvements in the operating procedures of the Branch.

(f) The ability of the Branch to staff itself, notwithstanding the limitations imposed by the Public Service Commission, is, in general, adequate to allow it to perform its functions. The financial review process enables the Deputy Minister to evaluate the effectiveness of the activities carried out and to assess the overall worth and impact of the programs of the Branch. In addition, the existence of delegated responsibility for the employment of consultants allows an adequate overload capability for activities that cannot be handled at the existing staff level. It should be noted that consulting expenditures over $5,000 are subject to the approval of the Deputy Minister and Treasury Board.

(g) If there is any major hindrance to the effective performance of the functions of the Branch, it is that the organization is classified as being engaged in economic research whereas, in actual fact, it must

2.2 cont'd.

by necessity secure professional personnel from various backgrounds and disciplines. The outlook of the Public Service Commission in classifying professionals, in respect of work in this Branch, and its reluctance at times to accredit professionals from disciplines other than economics (i.e., geography, mathematics and business administration) sometimes results in potential employees, highly skilled in their fields of specialization, being lost to private industry and universities. Further consequences of this approach are a resulting disproportionate demand for economists, the number of which available is limited, and the employment of economists at relatively senior levels to perform work which could better be carried out by persons having other backgrounds.

h) It is envisaged that during the next five years the Branch, in respect of the major changes to come about in organization functions, will focus its research activities on more pragmatic and shorter term aspects of transportation research while the newly formed Research Division of the Canadian Transport Commission will deal with longer term and intermodal transportation research problems pursuant to the provisions of the National Transportation Act.

2.3 PERSONNEL POLICIES:

(a) Members of the Branch, both alone and accompanied by representatives of the Public Service Commission, make annual visits to universities located in Canada, the United States and Great Britain, to interview forthcoming graduates. On various occasions the Branch also interviews

2.3 cont'd.

graduate students or members of their faculty in regard to sponsoring research assistants, thereby maintaining close liaison with promising advanced students. In addition, the Branch hires a limited number of summer students each year for the purpose of carrying out specific research assignments, and also to evaluate their effectiveness and stimulate their interest in the activities of the Branch.

(b) The Branch has found that the most successful researchers are those with whom it has been able to establish some type of employment or research assistant relationship during the years of undergraduate or graduate study. In selecting these people the Branch has relied on such conventional procedures as appraisal of academic studies, personal interviews, and consultation with professors and other members of the faculty.

(c) The members of the staff with high potentiality as research administrators are easily identified by virtue of the compact, integrated nature of the organization and the attendant ease of communication within. Furthermore, an opportunity is afforded to those people thus identified by assigning them to temporary administrative responsibilities during the vacation and travel periods of incumbent administrators.

(d) The salary differentials existing between researchers and research administrators are not great; for example, an Economist 6 (researcher) is paid approximately nine per cent less than an Economist 7 (research administrator). In this Branch, because of the diversified activity, the

2.3 cont'd.

only person functioning as a pure research administrator is the Director. Other administrative positions below this level have personal responsibility and participation in research in addition to administrative duties. Promotions within the Branch are therefore based on level of competence both as a researcher and as a research administrator.

(e) The policy of the Branch regarding education for staff members conducting or administering research is to give encouragement and financial assistance (within the confines of budgetary limitations), where it will be mutually beneficial to both the individual and the organization, to those interested in returning to university either for an advanced degree or refresher courses. It is directed at exposing the staff to new and improved concepts in the fields of transportation economics and technology and in other related areas as, for example, systems analysis and urban planning. Such exposure is also achieved through encouraging attendance at and participation in formal courses, seminars and conferences.

2.4 DISTRIBUTION OF ACTIVITIES:

(a) The program of the Transportation Policy and Research Branch involving the distribution of funds for specific research projects and fellowships was commenced in 1965. A regional breakdown of the monies expended is set out as follows;

2.4 cont'd.

	Alberta	British Columbia	Manitoba	Ontario
1965/66		$ 7,000		
1966/67		17,000	$ 1,500	$ 5,000
1967/68	$ 3,000	11,000	40,000	10,300

(b) The suitability of any region for transportation research grants is essentially dependent on the specialized university facilities in existence or in the planning stage. Universities often structure their research programs in response to local prevailing forms of transportation or transportation problems unique to or more pronounced in the area in which the institutions are located.

(c) Few activities have been carried out on an annual basis, during the last five years, to assist in the investigation of regional problems or phenomena. The bulk of the work of the Branch (as outlined below in section 2.9 (1))is in reference to research projects and studies with a somewhat irregular pattern of occurrence.

(d) Transportation is generally viewed as an integral and fundamental factor in contributing to regional development. Therefore, activities of the Branch which even indirectly assist in the improvement of transportation facilities have a corresponding and attendant effect on achievement in this regard. Accordingly, the role of the Branch is to seek to ensure that transportation facilities or the lack thereof are not a serious limitation to sound economic progress.

(e) A correlation of this nature is possible only in the case of a limited number of major projects.

2.5 (a)-(b)-(c)

2.5 (a) - (b) - (c)

PERSONNEL STATISTICS 1968

(a)	(a)	(a)	(b)	(c) NUMBER - COUNTRY - DEGREE LEVEL						(c) TOTAL YEARS SINCE		(c) AVERAGE AGE TOTAL			(c) %
EST.	ON STRENGTH	STATUS	ADMIN. DUTIES	PERSONNEL ON STRENGTH	BIRTH	SECONDARY EDUCATION	BACHELOR	MASTER	DOCTORATE	GRADUATION	PRESENT EMPLOYMENT	BA	MA	PHD	DUAL LANGUAGE
				7	Canada	Canada	Canada			53	18	37	39	31	38
32	22	S.O. 1	5	5	Canada	Canada	Canada	Canada		65	17				
		Ec. 18		3	Canada	Canada	Canada	U.S.A.		68	22				
		FI. 1		1	Poland	Ireland	Ireland			9	2				
		AO. 1		1	Austria	Austria	U.S.A.			9	4				
		TO. 1		1	Holland	Holland	Belgium			31	8				
				1	England	England	England	England		16	3				
				1	England	England	England	England	England	5	2				
				1	Scotland	Scotland	Scotland	Scotland		17	2				
				1	U.S.A.	U.S.A.	U.S.A.	U.S.A.		3	1				

2.5 (d)-(e)-(f)-(g)-(h).

2.5 (d) - (e) - (f) - (g) - (h)

YEAR	(d) PROFESSIONAL STAFF & ESTIMATES			(e) TURNOVER % BY DEGREES			(f) PREVIOUS EMPLOYMENT				(g) EDUCATION LEAVE		(h) NO. UNIVERSITY STUDENTS
	BACHELOR	MASTER	DOCTORATE	BA	MA	PHD	INDUSTRY %	UNIVERSITY %	PROVINCIAL %	FEDERAL %	MA	PHD	
1962	9	4	2	-	-	-					-	-	-
1963	7	4	1	22	20	-					-	-	-
1964	8	3	2	-	25	-					-	-	-
1965	14	4	2	-	-	-					-	-	-
1966	14	4	2	13	25	-					1	-	2
1967	10	9	-	33	-	100					1	-	3
1968	10	11	1				41	4	9	14	2	1	-
1969	Est.												
1970	"												
1971	"												
1972	"												
1973	"												

2.6 EXPENDITURES ASSOCIATED WITH SCIENTIFIC ACTIVITIES:

(a) i) The total funds spent by the Transportation Policy and Research Branch on scientific activities may be broken down as follows:

Research Spending by Function ($)

Functions	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
Intramural Research.	242,800	302,144	379,231	473,425	474,400	652,100	666,100	687,600
Support of R&D in Universities.	7,000	38,500	64,000	200,000	250,000	300,000	300,000	300,000

ii) The expenditures of the Branch on research have been and are about equally divided between engineering and technology, and economics:

Research Spending by Scientific Discipline ($)

	1965/66	1966/67	1967/68
Engineering and technology	141,400	151,072	139,615
Economics	141,400	151,072	139,616

iii) Areas of Application

The research expenditures of the Branch are devoted exclusively to the field of transportation.

(b) The Branch does not break down its expenditures on a divisional or sectional basis.

(c) Under the Departmental training program, funds are made available for the continuing education of promising members of the staff. The Branch has expended the following amounts on this type of training:

1965/66	$ 3,400
1966/67	12,000
1967/68	5,000
1968/69 (est.)	5,000

2.7 RESEARCH POLICIES:

a) Units concerned with intramural research activities:

1) Programs are established on the basis of need by a decision of the Minister or Deputy Minister sometimes in consultation with the heads of operating agencies such as Air Canada, Canadian National Railways, or the Canadian Transport Commission. Projects arise in the structuring of programs or originate as specific problems emanating from the House of Commons, by requests from industry, or by direction or interest forthcoming from various permanent and *ad hoc* interdepartmental committees, and from specific needs developing in the Air and Marine Services areas of the Department of Transport. It is customary for projects to be initiated by the Director frequently in consultation with the Deputy Minister. Time goals and staff requirements are established for various projects and these are monitored informally by means of weekly and sometimes daily consultations between the Director and the division chiefs. The larger projects are being shifted over to Critical Path Network monitoring.

2) There is a basic core of projects, mainly of a longer term nature, where priorities with respect to initiation and completion date are determined by a preliminary assessment of the financial or economic benefits likely to accrue, having due regard to staffing exigencies. Largely imposed upon this core of work are a varying number of emergent projects where priority is determined on the basis of the timing needs of the Department for information.

3) Both PERT and CPN methods have been employed to a limited degree. However, the Branch is still in the process of training and acquainting staff with such techniques. PERT has been used in

2.7 cont'd.

the Telecommunications Study for which the Branch provided an input. CPN has been used in paper flow and methods improvement work but it has not as yet been extended to major projects because of training limitations.

4) During the past five years intramural research in transportation has been supported by work contracted out to consultants. Various examples in this regard, with reference to the various transportation modes, are set out as follows:

(a) Air

i) Study of Air Travel Forecasting Techniques,
by Kates, Peat, Marwick & Co., April 1967.

The study was commenced in order to reveiw all available literature dealing with air passenger traffic forecasting and, in particular, the more modern techniques employed by the air carriers. Information and advice were received in reference to the most commonly employed and most promising of the new techniques, and were accompanied by a comprehensive evaluation of the advantages and disadvantages of each.

ii) Montreal International Airport Study,
by Kates, Peat, Marwick & Co., 1967.

This undertaking was initiated because of the need for expansion of present airport facilities and the apparent increasing resistance to aircraft noise in the vicinity of Montreal International Airport.

(b) Railway and Highway:

i) Atlantic Provinces Road Study,
Economist Intelligence Unit.

Commencement of this project began as a part of an overall assessment of transportation needs in the Atlantic Provinces.

2.7 cont'd.

ii) Northumberland Strait Crossing Study.

Involved in this study was a close integration of both intramural and extramural research activity in analyzing the economic factors surrounding the possible construction of a causeway which would link Prince Edward Island with the mainland.

iii) Matane Ste Anne des Monts Railway Study.

As in the previous example this also involved a combination of intra and extramural research.

(c) Marine

i) Port of Churchill Study, by Hedlin Menzies.

Basically extramural in nature, this work entails close co-operation with the Province of Manitoba and the Manitoba Royal Commission studying northern development.

ii) Study of Long Range Requirements for Harbour Facilities in Western Lake Ontario.

This endeavour was undertaken to identify traffic trends in the area in question taken as a whole, with a view to measuring the economic value of an application of Federal resources in the respective parts.

5. A survey made some years ago revealed a dirth of personnel in industry and government having a high degree of competence in modern techniques which could be directed towards the solution of transportation problems. This situation prompted the initiation of a program to encourage those who demonstrated potential to undertake graduate and research work in transportation. In addition, numerous factors such as the founding of the Canadian Transportation Research Forum and the development of a greater interest in the field on the part of students have resulted in a generally higher level of expertise, and have thereby enabled policy to shift away from broadly oriented research activities to those of a much more specific nature.

2.7 cont'd.

6. By the time most programs (such as those in respect of new airports) are undertaken they have sufficient priority that a shift of resources away from them is essentially impossible Most of the work of the Branch is, however, concerned with project rather than program research. As described earlier, the shifting of human resources, where found necessary, is accomplished by employing consultants.

7. The results of both intramural and contracted extramural research studies are normally made available to those having potential need of them. Certain studies, such as the General Aviation Survey, were forwarded directly by the Branch to all the interested parties; other studies have been made public through the distribution facilities of the Queen's Printer; while still other studies have been printed by the Branch and donated to government departments and agencies and those in industry and the universities known to have an interest in them.

8,9. The funds available to the Branch and the portions thereof spent on extramural research activities are described as follows:

Expenditures on Extramural Research Activities

Period	Total Funds Available	Total Funds Spent	Percentage Spent
1965/66	$ 81,700	$ 71,600	87.7
1966/67	485,000	487,379	99.9
1967/68	800,000	569,402	71.3
1968/69	1,030,000*	1,030,000*	100. *

* estimated

2.8 RESEARCH OUTPUT:

1. Patents and licences: None.
2. The members of the professional staff of the Branch normally publish several research articles per annum in the journals relevant to transportation research.
3. The Branch usually issues approximately fifty reports per year.
4. Among the conferences employed (and the groups sponsoring them) as a means of disseminating research information emanating from the Branch have been the following: Canandian Transportation Research Forum, Canadian Port and Harbour Association, Permanent International Association of Navigation Congress, Rail Systems and Management Association, World Road Congress, Airports of the Future, Air Cushion Vehicles Symposium, Urban Transportation Conference, International Air Transportation Association, American Association of Port Authorities, International Container Conference, International Union of Public Transport, Air Cargo Forum, and the Canadian Economic Association. In addition, the Branch transfers information regarding its activities by means of membership and participation in interdepartmental committees concerned with such considerations as the Seaway, Great Lakes Harbours, Air Cushion Vehicles, Containerization, Northern Transportation, Roads and Highway Policy, and the proposed Northumberland Strait causeway.
5. The Branch maintains close liaison with a Departmental representative in London who screens the trade press and scientific journals and forwards excerpts or summaries along with other requested information. A research information sharing agreement was recently negotiated between the Secretary of Transportation in Washington and the Department of Transport. In addition,

2.8 cont'd.

the former Director of the Transportation Policy and Research Branch and now Commissioner of Research for the Canadian Transport Commission maintains committee membership in the O.E.C.D. which provides the Branch access to relevant research papers from United Nations members on an exchange basis.

6. Among those who have had the opportunity of being able to train themselves in transportation policy and research techniques while employed with the Branch and have subsequently left and made important contributions in the field are: T.H. Kuhn, Professor of Economics, York University, K. Studnicki-Gizbert, Associate Professor of Economics, York University, and R.R. Cope, Commissioner, Canadian Transport Commission.

7. As yet, no research teams have arisen who have unique and valued abilities in any of the fields comprising the operations of the Branch.

8. Most of the work of the Branch is in the area of applied research, and the organization has tended to draw upon developed methodology and tools. There are no clearly known instances of the development of unique methodology which could be attributed to the Branch.

9. The purpose of national transportation policy, which is a prime consideration in the operations of the Branch, is to obtain the optimum utilization of transportation resources consistent with the public interest. As transportation costs constitute approximately 25 per cent of Gross National Expenditure, even relatively small overall changes in transport efficiency will benefit all Canadians. A considerable amount of the development work with regard to the preparation of the National Transportation Act was carried out in the Branch.

2.9 PROJECTS

(1) An essentially complete list of the various projects undertaken within the Transportation Policy and Research Branch, during the period 1962 to 1968 inclusive, is set out, on a divisional basis, as follows:

(a) Air Economics Division:

Many of the projects dealing with local airport assistance form a part of the broader Federal program of financial assistance for the development of such airports. Projects falling within this program are indicated with an asterisk:

1964

1. Proposed Development of Additional Remote Airports on the North shore of the St. Lawrence.
2. Calgary Air Terminal Building.
3. New Terminal Building at Val D'Or, P.Q.
4. Revelstoke Airport, B.C.
5. Airport Revenues - Objectives and Changing Principles.
6. Charlo, N.B. Airport - Request for Paving Runway, Lighting, etc.

1965

1. Toronto International Airport - Terminal Facilities.
2. Proposed Air Terminal Building at Goose Bay, Labrador.
3. Proposed Terminal Building at Charlottetown, P.E.I.
4. New Terminal Building at Fort Nelson, B.C.
5. Proposed Air Terminal - Operations Building at Hay River, N.W.T.
6. Proposed Public Waiting Facility (Operations Building) at Terrace, B.C.
7. Proposed Extension to St. John's, Nfld. Airport Terminal.

2.9 cont'd.

1966

* 1. Proposed Local Airport at Sorel, P.Q. Request for Financial Assistance.

* 2. Proposed Local Airport at Unity, Sask.

3. Montreal International Airport - Car Parking Requirements.

4. New Terminal Facilities - Yarmouth, N.S.

5. Terminal Building and Related Facilities - Bagotville.

6. Proposed Airport at Gillam, Island Lake and Norway House, Manitoba.

7. Proposed Airport Terminal Building at Brandon, Manitoba.

8. East Kootenay, B.C. - Proposed Air Terminal Building.

9. Air Canada Aircraft Acquisition Planning.

10. An Assessment of the DeHavilland Analysis of Twin Otter Services on the Prairies.

11. United States Aviation Growth and FAA Airport Policy.

* 12. Welland Airport, Ont. - Application for Financial Assistance by Welland - Port Colborne Airport Commission.

13. Moosonee, Ont. - Brief from Ontario Northland Transportation Commission, North Bay.

* 14. Alert Bay, B.C. - Request for Local Airport Assistance.

15. Renfrew County, Ont. - Airport Feasibility Study.

* 16. Oakville-Burlington, Ont. - Application for Airport Capital Assistance.

17. Sandspit, B.C. - Proposed Air Terminal Building.

1967

1. Sioux Lookout, Ont. - Proposal to extend the Runway.

* 2. Fort Albany, Ont. - Application for Airport Capital Assistance.

* 3. Dryden, Ont. - Application for Local Airport Assistance.

* 4. Chapleau, Ont. - Application for Local Airport Assistance.

2.9 cont'd.

* 5. Maniwaki, P.Q. - Application for Local Airport Assistance.

6. Economic Survey Report - Peace River Airport, Peace River, Alta.

* 7. Creston, B.C. (Rykerts-Porthill) - Application for Airport Capital Assistance.

* 8. Ross River, Y.T. - Application for Airport Capital Assistance.

* 9. Woodstock, N.B. - Airport Capital Assistance.

* 10. Edmonton Municipal Seaplane Base and Airport (Cooking Lake)- Application for Airport Capital Assistance.

11. Drumheller, Alta. - Application for airport Capital Assistance.

* 12. Eston, Sask. - Application for Airport Capital Assistance.

* 13. Lanigan, Sask. - Application for Airport Capital Assistance.

14. Prince Rupert, B.C. - Economic Projection of Seal Cove Sea-plane Base.

15. Fort Smith, N.W.T. - Air Terminal Public Space Requirements.

* 16. Chilliwack Municipal Airport, B.C. - Application for Airport Financial Assistance.

* 17. Vernon, B.C. - Application for Airport Financial Assistance.

* 18. Fort St. James, B.C. - Application for Airport Financial Assistance.

* 19. Elliot Lake, Ont. - Application for Airport Financial Assistance.

20. Resolute Bay Airport - Economic Survey for Future Airport Development.

* 21. Thetford Mines, P.Q. - Application for Airport Capital Assistance.

* 22. Amos, P.Q. - Application for Airport Financial Assistance.

23. Runway Requirements at Matane, P.Q.

* 24. Brome-Missisquoi-Shefford Airport - Request for Financial Assistance.

25. Domestic Market Potential of Hamilton-Niagara Area.

26. Comments regarding the report: "Applicability of the Boeing 727-100C, 707-320C and 747F to Ore Transport" by the Boeing Company.

2.9 cont'd.

27. Inuvik and Norman Wells Airports - Proposed Paving of Runways.
28. Gander Airport - Economic Survey and Forecast Space Requirements.
29. Background Paper on Supersonic Aircraft, for the Cabinet Committee on Communications and Works.
30. Aviation Relations between Canada and the Commonwealth Caribbean Territories.
31. Comments on the Kates, Peat, Marwick & Co. Report Showing Traffic Forecasts for Montreal International Airport.

(b) Marine Economics Division:

1962

1. Economics of Winter Navigation in the Gulf of St. Lawrence and Lower St. Lawrence River.
2. Study on Location of Hay River Railway Wharf.
3. Implications of Terminating Reciprocity on Great Lakes Harbour Dues.
4. Analysis of Economics of Proposed Matane Ste Anne des Monts Railway Project.
5. Study of Harbour Development and Pilotage at New Westminster, B.C.
6. Study of Proposed Ottawa, Ont. to Georgian Bay Deep Water Canal.

1963

1. Study of Transportation Requirements of Magdalen Island.
2. Analysis of Improvements to Prince Edward Car Ferry Services.
3. Analysis of Improvements to North Sydney, N.S. - Port aux Basques Ferry Service.
4. Evaluation of Requirements for Additional Nova Scotia to New England Ferry Service.
5. Analysis of Export-Import Trade at Halifax, N.S. and St. John, N.B.
6. Review of Steamship Service Subsidies.

2.9 cont'd.

1964

1. Review and Forecast of Traffic and Tolls on St. Lawrence Seaway.
2. Review of all C.N.R. Services to Newfoundland.
3. Economic Evaluation of Richelieu - Lake Champlain Canals.
4. Appraisal of Policy Alternatives regarding Canadian Merchant Marine.
5. Reappraisal of Steamship Subsidies.

1965

1. Reappraisal of North British Columbia - Alaska Transportation.
2. Study of Economic Significance for Canada of Waterborne Commerce, including analysis of traffic at important ports.
3. Study of Economic Potential of a Deep Water Harbour at Matane.
4. Evaluation of the need for proposed North Sydney, N.S. to Argentia, Newfoundland, Ferry Service.
5. Analysis of Improvements to St. John, N.B. - Digby, N.S. Ferry Service.

1966

1. Traffic Projection of Great Lakes to 1995, for Iron Ore, Grain, Coal and Stone, on a Lake-to-Lake Basis.
2. An Analysis of the Economic Benefits of Deepening the St. Lawrence Ship Channel.
3. Economics of Winter Navigation to Montreal and Port Alfred.
4. Develop methodology to evaluate benefits to commercial navigation of Great Lakes water levels control.
5. Survey and Analysis of Inland Shipping in 1964.
6. Develop estimates of operating costs of Great Lakes Vessels.

1967

1. An Analysis of the Effect on Hamilton of Welland Canal Tolls at Cost Recovery Level.
2. Benefits of Great Lakes Regulation of Recreational Boating.

2.9 cont'd.

3. A study of the shore facilities required to accomodate super lake vessels.
4. A study of long range requirements for harbour facilities in Western Lake Ontario.
5. An Analysis of potential benefits of winter navigation to Montreal and Port Alfred.
6. Projection of Great Lakes fleet to 1995, by vessel size, for the carriage of iron, coal and grain.

(c) Railway and Highway Economics Division:

1966

1. Preliminary study of comparative costs of an integrated rail and sea transportation system for the movement of grain to Europe.
2. Analysis of possible impact of a railway strike on the Canadian economy.
3. Studies of the assistance given by the Canadian Government to the Canadian travel industry.
4. Analysis of future grain handling facilities on the Pacific coast.
5. The development of a guaranteed railway network in the Prairie Provinces.
6. A forecast of anticipated passenger traffic to Expo.
7. A review of the problems foreseen by the Canadian transportation industry on application of the Canada Labour Standards Code.
8. A review of the bargaining over railway rates on Crows Nest coal destined for export to Japan.
9. A comprehensive transportation study of the Atlantic Provinces.
10. An analysis of alternative means of transporting supplies from Goose Bay to Churchill Falls.
11. A study of commodity transportation to and through West Coast ports.

2.9 cont'd.

1967-68

1. Atlantic Provinces Road Study.
2. Port of Churchill Study.
3. Digby-Saint John Ferry Service Study.
4. Northumberland Strait Crossing Study.
5. Halifax Bridge Study.
6. Roberts Bank Study.
7. Northern British Columbia and Yukon Development Study.
8. Research on the development of the motor carrier industry in Canada. This endeavour seeks, over a two year period, to determine and evaluate the size and rate of growth of the industry, the degree of competition and size of firms involved, the amount of railway ownership, and the nature of existing regulation.
9. Review of LCL and non-carload rates.
10. Railway cost study on P.E.I., which is part of the greater assessment of the proposed causeway to link the island with the mainland.
11. Economic analysis of Windfall Branch line.
12. Benefit cost analysis of various bridge and tunnel schemes for crossing Burrard Inlet.

(2) A significant number of the projects undertaken by the Transportation Policy and Research Branch are classified. However, the following seven studies have been selected as being typical of the work in the applied research and developmental areas (No basic research is undertaken):

2.9 cont'd.

1. Air Traffic Forecasts.

Each year, the Transportation Policy and Research Branch is asked by various parts of Air Services to prepare forecasts to assist those responsible for planning and designing facilities for air transportation. Normally, these forecasts take the form of predictions of annual and peak hour traffic volumes ten or twenty years in the future for around 20 specific airports and broken down into domestic, transborder and international segments.

The forecasts of annual passenger volumes are selected after forecasts are made using four different techniques:

(i) Fitting straight lines to past data collected by the Aviation Statistics Centre by the method of least squares and projecting these lines into the future.

(ii) Fitting exponential curves by the method of least squares to past data and projecting them into the future.

(iii) Predicting total Canadian traffic and the proportion of this traffic at each site based upon an analysis of past trends. The prediction of total Canadian traffic is at present derived from a mathematical analysis of the relationship between Canadian GNP (in current dollars) in the past and the total number of Canadian boarding passengers.

(iv) Analyzing past traffic growth by route and applying adjusted future growth rates based upon a detailed knowledge of the influence of service qualities, prices, communities of interest, degree of competition (etc.) in the past and any predicted changes in the interrelated effect of these key determinants in the future.

2.9 cont'd.

These forecasts of annual volumes are translated into peak hour forecasts on the basis of ratios between the two variables which have been derived from statistical studies of past relationships. The Aviation Statistics Centre collects sample data showing the number of enplaned passengers at Canadian airports by hour of the day. The Branch, in turn, sorts this data into order of descending magnitude and applies a slope formula to select a peak hour to be used for design purposes. The discovery that there has been a fairly stable relationship between past selected peak hour volumes and annual traffic volumes has made possible the derivation of a peak hour forecast from an annual forecast. Since ASC data are now available for a period of six years, the Branch has recently been able to acquire enough data to test the effect of certain factors on this relationship. A research study is presently underway to determine whether or not the relationship varies over time, in accordance with such factors as the degree of competition at a station, the category of traffic encountered (i.e., domestic, trans-border, international), or the size of aircraft employed.

2. <u>BWIA/Air Canada Liaison.</u>

Early in 1967, the Government of Trinidad and Tobago requested the Canadian Government to study the possibility of providing assistance to British West Indian Airways. Air Canada officials thereupon visited the Caribbean to determine the form and estimate the cost of assistance required by BWIA. After the President of Air Canada had reported on this visit, the Deputy Minister of Finance asked that a benefit/cost study of the proposal be prepared. Such a study was subsequently carried out within the Transportation Policy and Research Branch of the Department of Transport.

As a first step in the benefit/cost analysis, alternative courses of action were set up which the Government of Trinidad and Tobago might follow if assistance from Canada was not forthcoming. Next, a list of both intangible and tangible benefits was prepared and estimates of the values of the tangible benefits were prepared based upon a range of possibilities depending upon the outcome of future negotiations. A suitable number of years over which to measure the flows of costs and benefits was selected, and Air Canada's cost estimates were converted into the same form as the benefit estimates by discounting them to a present value amount using two different discount rates to give decision-makers an impression of the degree of sensitivity of the results to different assumptions regarding the appropriate interest rate.

The estimates of benefits and costs were referred to both Air Canada and Department of Finance officials for comment before a final report was prepared.

This benefit/cost study was employed to assist in preparing Canadian positions vis-a-vis the proposal but, in the end, the Trinidad and Tobago Government accepted an offer of assistance from a New York investment banking firm.

3. Scheduled Helicopter Operations in Canada - Feasibility Study.

In a report, completed in July of 1966, the three most promising potential areas for scheduled helicopter services were delineated and forecasts of passenger volume were made based on price levels which took into account the fares charged for such services in the U.S. and the charges of competitive modes of transport. Detailed cost estimates were prepared using data from U.S. operations adjusted for

2.9 cont'd.

Canadian input prices. It was concluded that the annual losses resulting from such operations would range from $1.5 million to $2.6 million under optimum conditions, and that subsidies of this magnitude could not be justified at the time in question. It was therefore recommended that the matter be again reviewed five years hence.

4. Development of the National Transportation Act.

As a result of the MacPherson Royal Commission on Transportation the Federal Government decided to develop legislation to reflect the economic principles embodied in the Royal Commission Report. As this report dealt primarily with rail and road problems the principal task for drafting the legislation fell on the Railway and Highway Division of the Transportation Policy and Research Branch.

A first step was to develop a clearly defined National Transportation Policy. This was accomplished only after careful examination of the economic and regulatory principles set out in the Royal Commission Report, and the most careful examination of how application of these principles would affect the various modes of transportation operating in Canada. The statement of National Transportation Policy subsequently appeared as paragraph 1 of the National Transportation Act.

Following the development of basic policy it was necessary to recommend amendments to existing legislation and in some cases to prepare new draft legislation in order to reflect this policy. In undertaking this task, existing rail legislation (The Railway Act) was compared with the Royal Commission Report and Recommendations. Changes in economic and regulatory principles were then identified and applied in drafting major amendments to this Act. In the case of Highway Transportation a major change to possible federal

2.9 cont'd.

regulation of the extra-provincial motor carrier industry was contemplated. As existing federal legislation did not provide for federal regulation of the bus or truck industries, completely new legislation had to be developed. This was accomplished only after exhaustively studying the economic characteristics of the bus and truck industries, other regulatory systems and their supporting legislation, and by consistently applying the economic and regulatory principles as identified in the Royal Commission Report.

The result of this work was the National Transportation Act, for which Royal Assent was given on February 9, 1967.

5. Analysis of Road Transport on Major Inter-city Corridors of Canada.

This Report, completed in September 1968, studied and classified, by type of operation, the general freight carriers operating between cities located on the major highway networks. Service was analyzed in order to determine the segments of total traffic that were carried by both federal and provincial carriers and an investigation was undertaken to indicate the intensity of competition along the corridors. In addition, the comparative effects of provincial regulation of routes, trailer interchanges and tariffs were also studied. The research undertaken during the study involved meetings with regulatory boards of the various provinces and with numerous private trucking companies. The study yielded detailed knowledge of the competitive structure of the industry and provided a clear indication that the major share of corridor traffic was carried by extra-provincial carriers while purely intra-provincial operators served mainly as feeders to mainline operators.

2.9 cont'd.

6. Economic Benefits of Deepening the St. Lawrence Ship Channel between Montreal and Quebec City.

As part of a benefit-cost study to determine the desirability of deepening the 35-foot Ship Channel, a detailed assessment was made of the economic benefits derivable from providing 39 feet of water, for comparison with the estimated costs of the required engineering works. The study was prompted by the Ship Channel's inability to accommodate a growing proportion of the world's merchant fleets, owing to a continuing trend toward the building of very large, deep-draft ships, particularly bulk carriers and tankers.

The potential economic benefits from a deepened Ship Channel were measured in terms of reductions in transportation costs realizable through the accommodation of the larger, more economic, ships. This was done by reference to relevant cargo traffic in 1964 at five Ship Channel ports (Montreal, Contrecoeur, Sorel, Trois-Rivieres, Quebec), broken down by the principal commodities involved and by size-groups of the ships carrying them. The assumption was that the comparative use made in 1964 of ships having drafts approximating the Ship Channel limit was indicative of the potential use of still larger ships on a deepened Channel. Estimates were made of the reductions in transport costs realizable over 50 years -- the amortization period selected for the deepening project -- drawing upon long-term traffic forecasts and data on ships' costs.

The investigation showed that a deeper Ship Channel could produce significant reductions in transport costs on the movement of four bulk commodities: crude oil, petroleum products, grain, and iron ore. However, on the basis of comparison of these estimated cost reductions with the

2.9 cont'd.

estimated cost of the engineering works to deepen the Ship Channel beyond 35 feet it was recommended that deepening of the channel be deferred. Work is continuing to establish more refined engineering costs and economic benefits.

7. Automobile Ferry Service Between the Mainland and Eastern Newfoundland.

Description

This assignment was related to the initial concept, general planning, the supervision and/or performance of economic, technical and engineering feasibility surveys, the co-ordination and liaison between federal, provincial, municipal agencies, and finally the preparation and approval of rate schedules in connection with the establishment of a ferry service between North Sydney N.S. and Argentia Nfld. The service was inaugurated in June 1968 by the "MV Ambrose Shea", an ice-breaking ferry accommodating 310 passengers, 60 automobiles and 20 trucks; making 3 round trips weekly.

Outline of Approach.

In September 1959, the Interdepartmental Committee on Atlantic Transportation, chaired by Mr. R. B. Bryce, recommended as the result of a two-year preliminary study that the Department of Transport prepare an economic analysis of the feasibility of an automobile ferry between North Sydney and Argentia. Most of the input to this Inter-departmental Committee's research had been supplied by this Branch in co-operation with CN and Department of Public Works.

2.9 cont'd.

In the following two years, the Branch engaged in comprehensive economic cost-benefit studies, discussions and negotiations relating to the many essential elements determining the various alternative systems which might be considered. These elements comprised the type of vessel (speed, size, configuration, crew, schedules, operating costs, etc.), the terminals and ancillary facilities, the road connections, freight carrying capability as required by CN, etc.

The Cabinet approved in September 1961 the Interdepartmental Committee's recommendation for establishment of an Eastern Newfoundland Ferry Service as developed by D.O.T.

When the decision became public, the Branch was called upon to investigate, evaluate and draft policy decisions regarding many alternative proposals as well as minor or major modifications of the proposed service. For instance, such proposals sought the use of Louisbourg, Halifax, Port Hastings and Sydney (in N.S.) and Marystown, Little South Harbour and St. John's (in Nfld.) as terminals or ports of call.

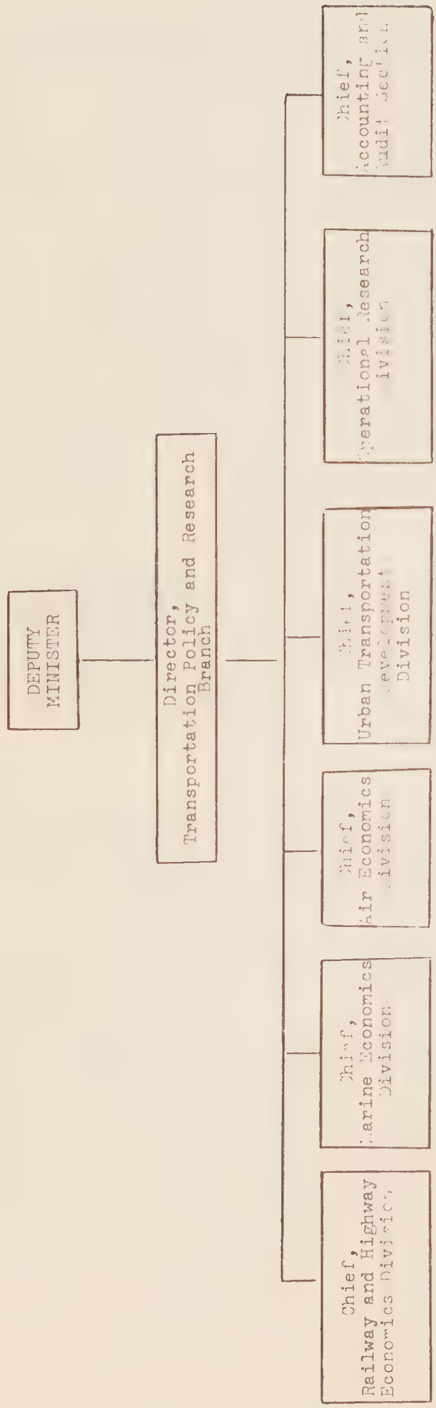
The co-operation of the U.S. Navy regarding the Argentia terminal and access to it was secured satisfactorily as was the indispensable road link between the terminal and the Trans-Canada Highway on the Avalon Peninsula. The North Sydney terminal was also planned and construction supervised from a cost-efficiency point of view.

Planning and construction of the "Ambrose Shea" was supervised and co-ordinated with the assistance of CN, the Canadian Maritime Commission, DPW and the Department's Shipbuilding Branch.

As the vessel neared completion a final survey was made of potential traffic and tariffs were finalized. These formed the basis for the operation which went into effect in June 1968.

ORGANIZATION DIAGRAM

TRANSPORTATION POLICY AND RESEARCH BRANCH



SECTION V

Submission of the
TELECOMMUNICATIONS AND
ELECTRONICS BRANCH
Department of Transport
to the
Senate Committee on Science Policy

1968

DEPARTMENT OF TRANSPORT

TELECOMMUNICATIONS AND ELECTRONICS BRANCH

INTRODUCTION

The Telecommunications and Electronics Branch, through the medium of its Research, Development and Programming Division, conducts applied research and development in the field of electronics as applied to Air and Marine transportation and meteorology. The work of the Division is problem oriented and confined to applied research and development only. No attempt is made to conduct basic research.

The aim of the Division is to seek and provide solutions to problems arising in the operational branches of the Department which are amenable to solution by electronic means and where suitable equipment is not already available to develop equipment or systems which will provide the most satisfactory and economic solution.

(2.1) ORGANIZATION

2.1 (a) Figure No. 1 shows the relationship of the Research, Development and Programming Division within the Telecommunications and Electronics Branch and the relationship of the branch to the other branches of Air Services.

2.1 (b) The Telecommunications and Electronics Branch reports through the Assistant Deputy Minister, Air Services, to the Deputy Minister of Transport. It has no formal connection to other Federal Agencies or advisory committees.

2.1 (c) Figure No. 2 details the organization of the Research, Development and Programming Division.

2.1 (d) The Telecommunication and Electronics Branch and specifically the Research and Development Division takes part through formal agreements in the work of international technical and scientific bodies such as the International Civil Aviation Organization, the Inter-governmental Maritime Consultative Organization, the Radio Technical Commission for Aeronautics, and the Radio Technical Commission for Marine.

2.1 (e) Not applicable.

2.2. ORGANIZATIONAL FUNCTIONS

2.2 (a) The Research, Development and Programming Division supplies a problem oriented applied research and development service in support of the operational branches of the Department of Transport in all areas of electronics as applicable to Air and Marine transportation and the Meteorological service as required. As such its statutory functions and powers stem from the Civil Aeronautics Act and the Marine Transportation Act.

2.2 (b) The policy of the Telecommunications and Electronics Branch in respect to research and development is to conduct feasibility studies, to develop system concepts and to develop electronic equipment and systems which will meet the requirements of the operational branches in the most satisfactory and economical manner and which thereby assist and improve the safe, expeditious and economical movement of Air and Marine traffic.

2.2 (c)(i) The branch has no specified functions or responsibilities for research and development in respect to other Federal Agencies but does on occasion carry out feasibility studies, provide information or advice and conduct experimental and evaluation work on behalf of or in conjunction with such agencies.

2.2 (c)(ii) The branch has no specified functions or responsibilities in respect to industry but of necessity it does work closely with the electronics manufacturing industry using industry both as contractors for development of prototype equipment and as a source of information on the latest electronic techniques. Conversely industry derives information which enables them to direct their own Research and Development effort.

2.2 (c)(iii) The branch is not closely connected with educational institutions in Research and Development. These institutions are geared more to basic research than to applied research but on occasion contracts for applied research have been awarded to universities.

2.2 (c)(iv) Very intensive monitoring of developments in other countries is a continuing function. This is conducted by liaison with equivalent organizations in other countries and by representation

on such international bodies as the International Civil Aviation Organization and the Inter-governmental Maritime Consultative Organization, the Radio Technical Commission for Aeronautics, the Radio Technical Commission for Marine etc.

2.2 (d) Operational effectiveness duties and goals are reviewed and revised by way of the Air Services planning and estimates processes which are subject to Treasury Board review, and approval.

2.2 (e) None

2.2 (f) The Research, Development and Programming Division's duties and responsibilities flow from the activities of the Agencies directly responsible for the administration of the Civil Aeronautics Act and the Marine Transportation Act. This service organization concept provides a satisfactory guidance sufficient to develop economical, realistic and timely programmes directed to solutions of the problems arising from administration of the above Acts.

2.2 (g) The major hindrance to the effective conduct of our research and development activities is the difficulty experienced in attracting suitable personnel. Applied research and development is always at a disadvantage when competing with basic research in the area since the latter has a greater allure for the best best brains.

2.2 (h) No major changes in organization functions in the next five years are anticipated.

2.3 PERSONNEL POLICIES

2.3 (a) In selecting university graduates every effort is made to select on the basis of intelligence, initiative, motivation and an inquiring mind. Selection is made by examination of academic records, discussion with professors and personal interviews.

2.3 (b) No specific criteria have been developed other than (a) above.

2.3 (c) A continuous appraisal of staff is conducted. It is usually not difficult to discern those whose motivation and abilities are directed to administration.

2.3 (d) Of necessity administrators in this field must be professionally qualified. Promotion is controlled by criteria established by the Bureau of Classification Revision. Remuneration is governed by the salary rates established for the position.

2.3 (e) Intramural education is conducted through the medium of Departmental administrative courses and specially arranged technical courses. Every encouragement is given to personnel to take extramural post graduate courses. Financial assistance is provided in such cases subject to regulations established by Treasury Board.

2.4 DISTRIBUTION OF ACTIVITIES

This question is not applicable in that the activities of the Research, Development and Programming Division are not regionally oriented.

2.5 PERSONNEL ASSOCIATED WITH SCIENTIFIC ACTIVITIES

2.5 (a) The establishment and strength of the Division are as shown below by category:-

	Establishment	Strength
Engineers	24	23
Engineering Students		3
Technicians Electronic	15	13
Administrative Support	7	7
Totals	46	46

2.5 (b) The number of professional staff devoting most of their time to administrative duties = 5.

2.5 (c)

	Country of Birth	Secondary & University Education	Average Age	Percentage Able to Operate in Both Languages
	2 - United Kingdom	2 - United Kingdom		
Bachelor	1 - Poland	1 - Poland	34	3%
	1 - India	1 - India		
	1 - Colombia			
	15 - Canada	16 - Canada		
Master	1 - Russia	1 - Russia	38	0
	1 - United Kingdom	1 - United Kingdom		
	2 - Canada	2 - Canada		
Doctorate	-	-	-	-

2.5 (d)

	1962	63	64	65	66	67	68	69	70	71	72	73
Bachelor	12	14	17	17	15	20	22	20	21	23	23	24
Master	1	2	2	2	2	4	7	4	4	4	4	5
Doctorate	-	1	-	-	-	-	-	-	-	-	-	-

NOTE: Reduction of staff in 1968 due to transfer to new Department of Communications

2.5 (e) The total professional staff turnover during the period 1962 to 1967 amounted to ten.

2.5 (f)(i) Percentage employed by industry since graduation = 46%

(ii) Percentage who have been on staff of universities since graduation = 17%.

(iii) None.

(iv) Percentage employed by other Federal Departments = 12%

2.5 (g) Nil

2.5 (h)

1962	63	64	65	66	67
0	0	0	0	0	5

2.6 EXPENDITURES ASSOCIATED WITH SCIENTIFIC ACTIVITIES

2.6 (a) Total funds spent by Research, Development and Programming Division on scientific activities:

Years	Function	Scientific Discipline	Areas	Funds
1962/63	Applied R&D -Electronics	Engineering & Technology	(a) Telecommunications (b) Transportation Electronics*	$ 64,000 $260,000
1963/64	"	"	(a) (b)	$474,000 $526,000
1964/65	"	"	(a) (b)	$6,103,000 $ 455,000
1965/66	"	"	(a) (b)	$4,991,000 295,000
1966/67	"	"	(a) (b)	$ 576,000 $ 376,000
1967/68	"	"	(a) (b)	$ 255,000 $ 722,000
1968/69	"	"	(a) (b)	$ 187,000 $1,387,000
1969/70	"	"	(a) (b)	$ 150,000 $1,280,000

Years	Function	Scientific Discipline	Areas	Funds
1970/71	Applied R&D -Electronics	Engineering & Technology	(a) Telecommunications (b) Transportation Electronics*	$ 160,000 $1,512,000
1971/72	"	"	(a) (b)	$ 175,000 $1,216,000
1972/73	"	"	(a) (b)	$ 190,000 $1,151,000
1973/74	"	"	(a) (b)	$ 200,000 $1,348,000

* such as: radar, navigational aids, digital displays, etc.

2.6 (b) Operating and capital funds expended by Research, Development and Programming Division:

1962/63	$ 324,000
1963/64	$1,000,000
1964/65	$6,558,000
1965/66	$5,286,000
1966/67	$ 952,000
1967/68	$ 977,000
1968/69	$1,574,000
1969/70	$1,430,000
1970/71	$1,672,000
1971/72	$1,391,000
1972/73	$1,341,000
1973/74	$1,548,000

The large expenditure during fiscal years 1964/65 and 1965/66 was occasioned by the construction of the Mill Village Earth Space Satellite Communication Station.

2.6 (c) The exact funds expended to further professional university education of staff are not available but are estimated to be less than $300 per year and are anticipated to remain at approximately the same level for the next few years.

2.7 RESEARCH POLICIES

2.7 (a)1. Programmes and projects are initiated either as a result of specific requests from an operating branch or internally as a result of an informed assessment of foreseeable requirements. Selection is realized by review by the operating branch and within the framework of the departmental planning and estimate procedures. Monitoring is achieved

through technical and financial audit.

2.7 (a)2. Priorities are established for programmes and projects by reviewing the urgency of selected items with the respective operating branches and establishing the relative priority of each item. Priorities are expressed in numerical sequence and implemented within the framework of available funds and manpower.

2.7 (a)3. Yes. Critical path network methods are used to plan and monitor programmes and projects. The particular method used depends upon the scope. With small projects the implementation may be entirely manual. In larger projects computer techniques are employed. The outstanding example of the latter is the construction of the Mill Village earth satellite communication station which involved several thousand activities.

2.7 (a)4. Where it is economically advantageous or where the necessary technical capabilities are inadequate intramurally, contracts for research and development projects are awarded to outside agencies. Examples of such contracts are the award to RCA Victor as prime contractor for design and construction of the Mill Village station, the award to IBM Canada for the air traffic control data processing system at Gander, Newfoundland, and the award to Airborne Instruments Ltd., Long Island, N.Y., for the development and supply of an experimental radar digitizer and display system, etc.

2.7 (a)5. There is no general policy regarding funding of extramural research programmes in universities. However, where the university is prepared to undertake a specific applied research and development project a contract is awarded on the same basis as it would be to industry.

2.7 (a)6. Resources are shifted between projects under the following conditions:-

(1) Completion of the project.

(2) Termination of project due to changes in operational requirements.

(3) Termination of the project due to advances in technology which render it obsolete.

(4) When a stage is reached where it is apparent that any further expenditure of resource is unprofitable.

2.7 (a)7. The results of intramural and extramural research and development are primarily directed to the satisfaction of departmental needs. They are disseminated to other interested agencies by means of reports, participation in symposia, presentation of formal papers, etc.

2.7 (b) Not applicable.

2.8 RESEARCH OUTPUT

2.8.1 Nil

2.8.2 Calibration of C Band Radar, Proceedings of Thirteenth Radar Meteorology Conference 1968.

2.8.3 A list of reports issued in this period is contained in Appendix "A".

2.8.4 Not applicable.

2.8.5 Not applicable.

2.8.6 Not known.

2.8.7 None

2.8.8 (a) Mill Village Earth Satellite Communications Station.

(b) Programmable film scanner for retrieval of precipitation information from photographic film records of weather radar.

(c) A device for determination of rainfall rates at varying ranges by means of radar.

2.8.9 The impact of our research output is difficult to measure directly. The results manifest themselves in improvements in the air and marine transportation industries, e.g. Mill Village, Gander Air Traffic Control Data Processing System, St. Lawrence River Marine Traffic Control System, Current Air Traffic Control Radar Digitizer System, etc.

2.9 PROJECTS

2.9.1 List of Projects for Period 1962/67

Airborne Radar for Ice Reconnaissance

Long Range VHF

Closed Circuit Television

Infra-Red Systems

Transmission System Standards

Unattended Facilities

Nimbus Project

Satellite Communications

Navigation Satellites

Symbol Generation and Insertion System

Airport Surface Detection Equipment

AASR-1 Radar Coverage

Icebreaker/Helicopter Navigation

Study of Angel Activity

Radar Data Transfer

Weather Radar Improvement Programme

Radar Beacons

Data Posting and Display

Transcribed Weather Broadcast Equipment

Air Traffic Control Computer Systems

Automatic Weather Message Compiler & Digital Display

Teleprinter Receiver Evaluation

Forward-looking Echosounder

Transmissometer and Ceilometer Systems

Transmission of Radar Data - Microwave Links

Slowed Down Video

Radar Data Processing - Digital Computer and Analogue Computer

Video Enhancer

Wide Pulse Suppressor

Hydrometeorological Telemetry Stations

Doppler Weather Radar

Modification of AASR-1 Radar Console

Beam Phase Monitor for PAR

Precision Approach Radar Monitor

Radar Pattern Generator

Bright Display

Remoting of Secondary Radar

PERT Management Control

Digital Control Subsystem for DOT Ground Station

Satellite Communications Ground Station

Engineering and Scientific Computing Service

GP 804 Converter Modification

International Civil Aviation Organization

Vertical Pointing Radar

Ephemerides Computations for Communications Satellite

Programme Tracking and Timing Subsystem for DOT Ground Station

Satellite Station Antenna Velocity and Acceleration

Air Traffic Control Computer Systems

Equipment Serviceability and Component Failure Reporting System

GAS 4 - Working Group on Power Sources for Isolated Areas

Ground Station Equipment Testing

Curtiss-Wright Weather Radar

Processing of Filmed Weather Radar Data

T.V. Raster Flying Spot Scanner for Video Map Generation

Participation in Expo '67

St. Lawrence River Traffic Control

Remoting and Display of SSR/Prime Radar Digital Data

Flight Checking of Radio-Navigation Aids

Evaluation of Omega Navigation System Receiver

Wabush Lake Thermoelectric Generator

Programme Tracking and Timing Subsystem for DOT Ground Station.

Very Low Speed Data Transmission System

Landline Study - Digital Transmission by Modem Systems

Repair of L.F. Transistorized Beacon Transmitter

Calibration of C-Band Weather

Gander Automatic Air Traffic System (GAATS)

Morse Code Call Sign Detector

Toronto Automatic Air Traffic System (TAATS)

Canadian Atlantic Fisheries Information Service (CAFIS)

ILS Data Processing

Circuit Analyser

2.9.2 Case Histories

2.9.2.1 Display and Recording Equipment for Vertical Pointup Radars

This equipment was developed as an aid to cloud physics research. It converts the information obtained by means of the vertically pointing radar into a form suitable for recording on a standard facsimile receiver. The information such as cloud depth, density, layering, etc, is continuously recorded in terms of grey scale and is accompanied by a continuous recording of a calibrating signal. Thus a permanent record of the dynamic changes of a cloud is produced for subsequent detailed analysis.

Use of a standard facsimile receiver resulted not only in a very simple but an inexpensive solution as well. The data which can be gathered by these means is expected to be of a considerable value in extending the knowledge of the dynamic phenomena of clouds. In particular it is expected to be of aid in forecasting of extreme rainfall, cloudbursts, etc.

2.9.2.2. Determinations of the Rates of Rainfall by Radar

This development produced equipment which when incorporated into a C-band weather radar allows its use for determination of rates of rainfall at various ranges selectable at will by the operator within the radar's coverage.

The normal practice of using rain gauge provides this information only for the immediate vicinity of the rain-gauge site. The radar method allows a very detailed investigation of a large area of rainfall both on the ground, within a cloud and immediately below the cloud.

The method is simple and straight forward. So far as it is known this is the first simple and practical solution in answer to the long felt and frequently expressed need in international meteorological circles.

2.9.2.3. Gander Automated Air Traffic System

This system developed by the Telecommunications and Electronics Branch in co-operation with the Civil Aviation Branch was developed as a first step in the automation of air traffic control in that area of the North Atlantic Ocean for which Canada is responsible

for oceanic air traffic. The system provides air traffic controllers with "hands on" access to automatic data processing equipment and is intended to improve safety and expedition of air traffic and to relieve stress on air traffic controllers. The system was realized through a study of the problem, development of a philosophy of automation, development of system requirements, procurement of equipment, development of system tests, installation, testing to establish proof of performance, acceptance and activation. This system has been in operation since March 16, 1968.

2.9.2.4. Antenna Position Display System

An antenna position display system was designed, constructed and installed in the earth satellite ground Station, Mill Village, N.S. The system was required to convert binary coded antenna azimuth and elevation positions to degrees and fractions of degrees in binary coded decimal code for display on "Nixie" display indicators. The system features a novel method for code conversion and transmission of data from the local equipment to the remote displays.

2.9.2.5. Computer Programme for Ionospheric Data Reduction

The purpose of this computer programme is to generate and list medians and quartiles of ionogram data. Daily reports are read and processed according to the "URSI Handbook of Ionogram Interpretation and Reduction" and monthly reports are printed. The computer programme to accomplish this task was developed by a staff programmer and has been used for the production of reports since May 1966. As far as is known, Canada was the first country to accomplish this task.

2.10 Not applicable.

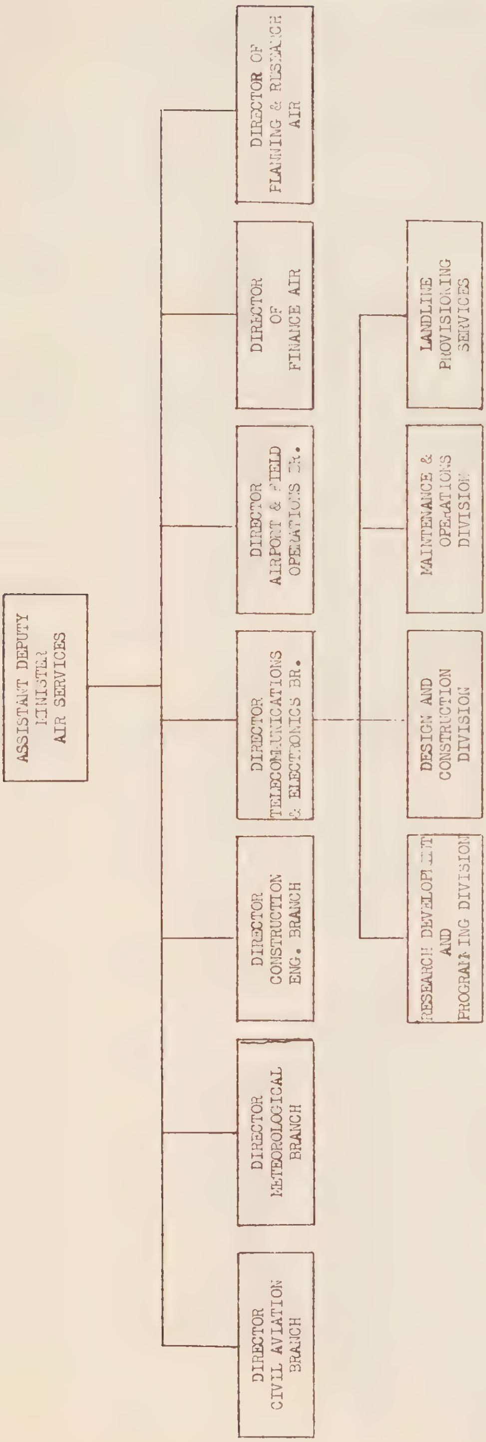

ASSISTANT DEPUTY MINISTER AIR SERVICES
DIRECTOR CIVIL AVIATION BRANCH
DIRECTOR METEOROLOGICAL BRANCH
DIRECTOR CONSTRUCTION ENG. BRANCH
DIRECTOR TELECOMMUNICATIONS & ELECTRONICS BR.
DIRECTOR AIRPORT & FIELD OPERATIONS BR.
DIRECTOR OF FINANCE AIR
DIRECTOR OF PLANNING & RESEARCH AIR
RESEARCH DEVELOPMENT AND PROGRAMMING DIVISION
DESIGN AND CONSTRUCTION DIVISION
MAINTENANCE & OPERATIONS DIVISION
LANDLINE PROVISIONING SERVICES

FIG. NO.1

2.1(c)

RESEARCH, DEVELOPMENT & PROGRAMMING DIVISION

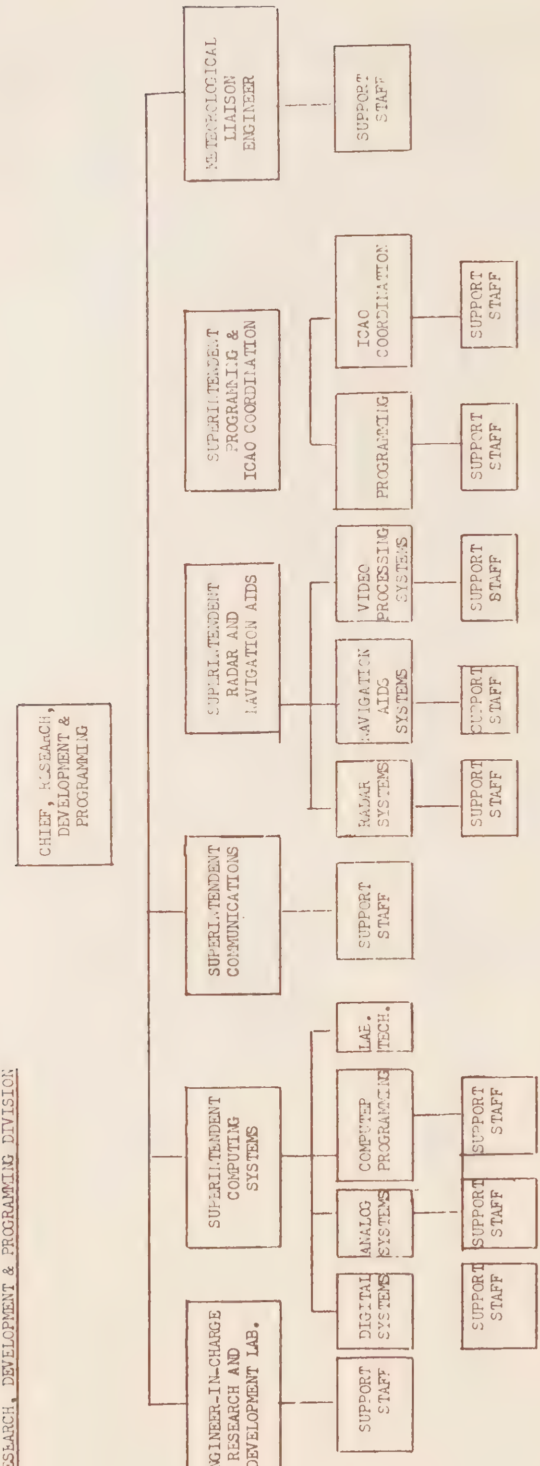


FIG. II.

CRD-RD-121-1	Development of Radar Test Pattern Generator for Radar Data Transmission Equipment Testing	Apr. 22, 1964
CRD-RD-122-1	Method of Radar Data Recording of Vertical Pointing Radar for Met. (Proposal #1)	(
CRD-RD-123-1	Method of Radar Data Recording of Vertical Pointing Radar for Met. (Proposal#2)	(April 29, 1964
CRD-RD-124-1	Method of Radar Data Recording of Vertical Pointing Radar for Met. (Proposal#3)	(
CRD-RE-125-1	Critical Path Scheduling Technique	Dec. 29, 1964
CRD-RD-126-1	Development of an MTI/Normal Video Amplifier and Mixing Unit	Dec. 21, 1964
CRD-RD-127-1	Development of a Trigger Regeneration Unit	Jan. 1, 1965
CRD-SY-128-1	Steering Tape Specification	Feb. 15, 1965
CRD-ST-129-1	Steering Tape Specification Synchronous Satellites	Mar. 26, 1965
CRD-RD-130-1	Radar Test Pattern Generator for Maintenance of Sel Radar Data Transmission System	April 26, 1965
CRD-RD-131-1	Computer Programmes for Random Satellite - Mill Village	June 9, 1965
CRD-RD-132-1	Precipitation Data Integrator	1966
CRD-RD-133-1	Modification to RHI Display of Curtiss-Wright Radar Set	Aug. 31, 1965
CRD-RD-134-1	Thermoelectric Power for Unattended Facilities	Dec. 21, 1965
CRD-RD-134-2	Thermoelectric Power for Unattended Facilities	Aug. 4, 1966
CRD-RE-135-1	Techniques and Estimated Costs of Radar Data Transmission	Nov. 3, 1965
CRD-SY-136-1	Specification for Gander ATC Computer System. Written by Civil Aviation	
CRD-RE-137-1	Present Uses of Nickel Cadmium Batteries in the Department of Transport and Future Possibilities	Nov. 15, 1965
CRD-RD-138-1	Remoting and Display of SSR/Prime Radar Digital Data, Review of ARTS System FAA	Jan. 19, 1966
CRD-RD-139-1	CRD-RDN-SSR-SEL Interface Equipment	Jan. 27, 1966
CRD-RD-140-1	Remoting and Display of SSR/Prime Radar, Digital Data	Mar. 9, 1966
CRD-RA-141-1	Voltage-gain Scaling for Analog Computers	Mar. 23, 1966
CRD-RE-142-1	Wabush Lake Thermoelectric Power Supply	Mar. 30, 1966
CRD-RD-144-1	Blipper Pen Activity	May 9, 1966
CRD-RE-146-1	Ionospheric Data Computer Programme	May 30, 1966
CRD-RE-146-1	Hybrid Simulation of the Mill Village Ground Station Antenna Control System	May 30, 1966
CRD-SE-147-1	Proposal for Modification of Antenna Position Displays at DOT Satellite Ground Station	1966

APPENDIX A

TECHNICAL REPORTS

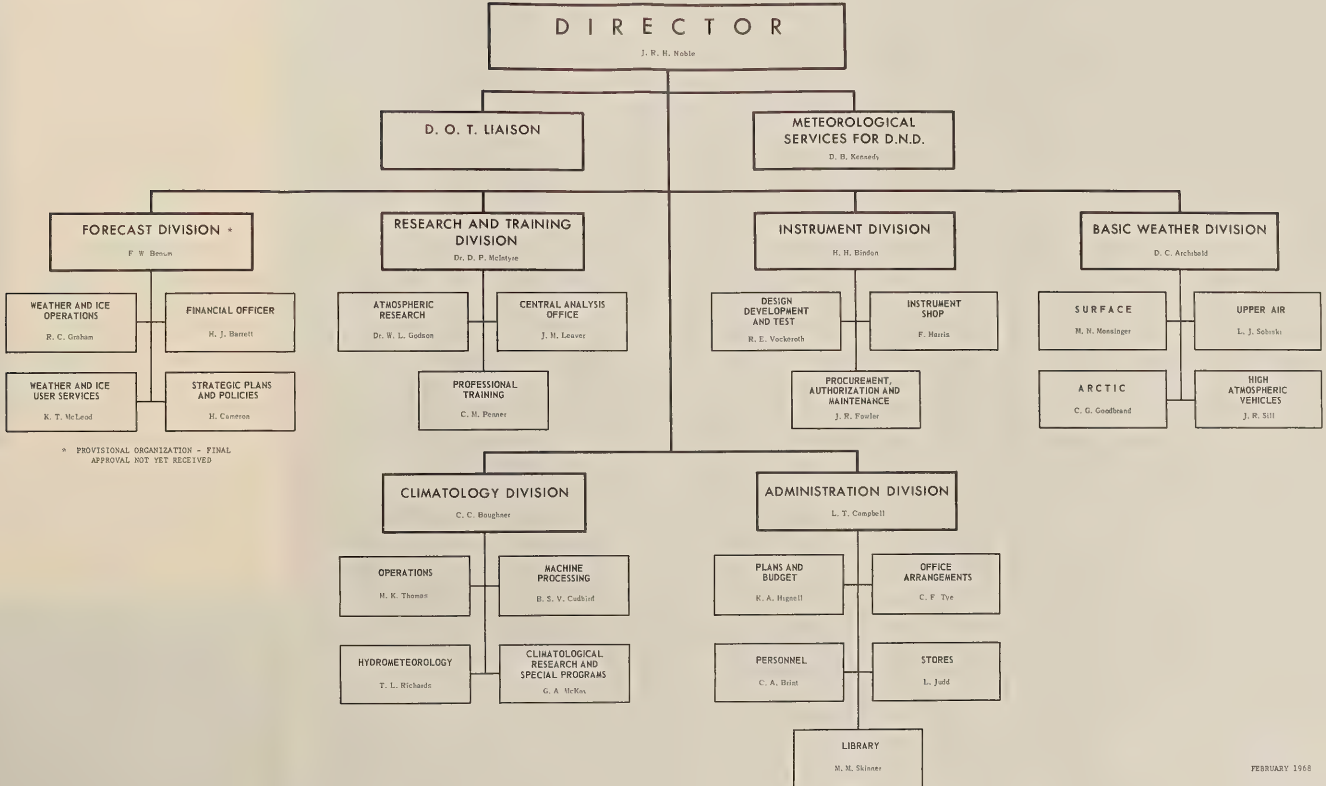
CRD-RC-100-1	Symposium on Nickel-Cadmium Batteries	Nov. 5, 1962
CRD-RC-101-1	Scattering from Rain at X-Band	Nov. 7, 1962
CRD-RA-102-1	Field Tests on Transmissometer and Ceilometer Systems	Nov. 21, 1962
CRD-SC-103-1	Channel Characteristics for the Transfer of Radar Data	Feb. 2, 1963
CRD-RA-104-1	Final Report on Character Cursor Injection Equipment with 804 & 801 Scan Converters	Jan. 10, 1963
CRD-RA-105-1	Final Report on Radar Data Transfer Using Pulse Time Techniques	April 26, 1963
CRD-RE-106-1	Evaluation of Marconi AD308 Airborne Teleprinter Receiver	Feb. 20, 1963
CRD-RE-107-1	Forward Looking Sonar	1963
CRD-RD-108-1	Reduction of Radar Ground Clutter by Means of a Wide Pulse Suppressor	Mar. 6, 1963
CRD-RA-109-1	Study of Angel Activity on Department of Transport AASR-1 Radars	Feb. 26, 1963
CRD-RA-110-1	Transmissometer and Ceilometer System Tests Using Telephone Cable	Mar. 7, 1963
CRD-RD-111-2	Modification of AASR-1 Radar Console for Use with ASR-3 Radar	Apr. 9, 1963
CRD-RE-112-1	Equipment Evaluation of the Experimental CCTV System Installed at Toronto International Airport	Mar. 14, 1963
CRD-RA-113-1	Laboratory Evaluation of Data Transmission Systems	Mar. 20, 1963
CRD-RD-114-1	Processing of Radar Video by Means of an Analogue Computer for Narrow Band Transmission	May 15, 1963
CRD-RE-115-1	Trip Report - Germany May 24-31, 1963 Technical and Operational Evaluation of Radar Data Transmission System - Standard Elektrik Lorenz FAB-6072	June 19, 1963
CRD-RE-116-1	Evaluation of Slowed Down Video Techniques for Long Distance Radar Data Transmission	Sep. 12, 1963
CRD-RE-117-1	Preliminary Engineering Report, Positive Radar Tracking of Helicopters from Shipboard Radar	Oct. 8, 1963
CRD-SY-118-1	Communications Satellite Earth Station, Digital Control System	Dec. 11, 1963
CRD-SE-119-1	Transcribed Weather Broadcast Equipment	Feb. 26, 1964
CRD-RD-120-1	Modification of GP804 Scan Converter for SSR Testing	Mar. 25, 1964

CRD-RD-148-1	Positive Tracking of Helicopter from Icebreaker Using SSR	July 12, 1966
CRD-RD-149-1	Processing, Remoting and Displaying of Prime and Secondary Data by Digital Techniques - Review of Progress	Dec. 1966
CRD-RD-150-1	Modifications to the Modulator Section of the LF Beacon Transmitter CRC/ABE-01	Jan. 16, 1967
CRD-RD-151-1	Real Time Data Acquisition Considerations for Initial ILS Flight Check Installation in Viscount Flight Check Aircraft	Feb. 17, 1967
CRD-RA-152-1	Proposal for Aircraft Instrumentation for Future VOR and ILS Flight Checking	Feb. 17, 1967
CRD-RA-153-2	General Purpose Simulation Using Electronic Computers	Feb. 23, 1967
CRD-RA-153-3	General Purpose Simulation Using Electronic Computers	Mar. 29, 1967
CRD-RD-154-1	Report on Summer Study of Meteorological Radar Calibration System	Aug. 28, 1967
CRD-RD-154-2	Report on Summer Study of Meteorological Radar Calibration System	Oct. 25, 1967
CRD-RD-155-1	Progress Report No. 3, Precipitation Data Integrator Project	Mar. 20, 1967
CRD-RA-156-1	Proposal for a Precision Blind Landing System to Replace ILS and Related Systems in the Next Generation Facilities	Mar. 20, 1967
CRD-RD-158-1	Digital Word Generator	May 2, 1967
CRD-RE-158-1	GAATS Acceptance Tests	May 3, 1967
CRD-RD-159-1	Slow Speed Data Transmission Project	May 29, 1967
CRD-SY-160-1	Digital Computer for R & D Projects - Statement of Requirements	May 30, 1967
CRD-RE-161-1	Instrument Landing System Evaluation (ILS) Part I Operating Procedures	Dec. 20, 1967
CRD-RE-161-2	Instrument Landing System Evaluation (ILS) Part II Operating Procedures	Sept. 28, 1967
CRD-RD-162-1	Transmission of Primary and Secondary Radar to T & E Systems Laboratory	1967
CRD-RE-163-1	Testing Modems and Modem Systems	Sept. 28, 1967
CRD-RD-164-1	Grey Scale Amplifier	Sept. 14, 1967
CRD-RD-165-1	Functional Specification for Radar Digital Data Display System	Oct. 13, 1967
CRD-RD-165-2	Tender Information Document for Radar Digitizing Equipment (Primary and Secondary)	Oct. 31, 1967
CRD-RA-166-1	R.D.C. Proposal for Data Acquisition for Canadian Atlantic Fishing Information Service (CAFIS)	Nov. 14, 1967
CRD-RE-167-1	CAFIS Project , Communications Feasibility	1967

Reports	1962	-	3
	1963	-	16
	1964	-	8
	1965	-	9
	1966	-	14
	1967	-	22
			72

CANADA - METEOROLOGICAL BRANCH - DEPARTMENT OF TRANSPORT

HEADQUARTERS ORGANIZATION



* PROVISIONAL ORGANIZATION - FINAL APPROVAL NOT YET RECEIVED

FEBRUARY 1968

RESEARCH AND TRAINING DIVISION

RESEARCH AND TRAINING DIVISION

1. Study of physical and dynamical problems relating to the atmosphere and liaison with other agencies in handling problems of a meteorological character.
2. Provision of analyses, prognostic analyses, extended range forecasts, and long range forecasts, as required by Forecast Division.
3. Professional training of meteorologists and prospective meteorologists and liaison with other agencies providing training in meteorology.
4. Development and testing of techniques for improved forecasting.
5. Provision of information, advice, and direction on research methods and meteorological literature.
6. Provision of technical editorial service and advice.
7. Technician training at Air Services Training School.

ATMOSPHERIC RESEARCH

1. Prosecution of research projects on physical, dynamical, and synoptic problems relating to the atmosphere.
2. Advice and/or supervision for research projects carried out in the field or by outside agencies.
3. Development of forecast techniques.
4. Provision of information on meteorological literature.
5. Assistance with professional training program as required.
6. Visiting scientists program.

SYNOPTIC RESEARCH

1. Statistical techniques for representing and predicting meteorological phenomena.
2. Study of mesoscale phenomena including research mesometeorological networks.
3. Meteorological influences on aircraft flight.
4. Development of techniques for special types of forecasts and advice and assistance to D.N.D. and other agencies.
5. Satellite Data Laboratory.

DYNAMIC RESEARCH

1. Numerical Weather Prediction.
2. Stratospheric meteorology and stratospheric - tropospheric interactions.
3. Upper atmosphere studies and high altitude observing systems.
4. General circulation.
5. Ozone Meteorology.
6. Extended Range forecasting.

PHYSICAL RESEARCH

1. Theoretical and empirical studies of long and short wave radiation in the atmosphere.
2. The calibration and behaviour of radiation instruments.
3. Atmospheric ozone determinations.
4. Ozone instruments.
5. Cloud and precipitation physics.
6. Radar meteorology.
7. Atmospheric electricity.
8. Cold fog dispersal.

Micrometeorology

1. Atmospheric Turbulence.
2. Air Pollution.
3. Energy Balance Studies.
4. Air-water interaction.

SERVICES

1. Mathematical and computational assistance.
2. Translations.
3. Technical support.

CENTRAL ANALYSIS OFFICE

1. Provision of weather map analyses, prognosis and advisories for civil and military meteorological establishments in Canada.
2. Provision of Extended Period Forecast service in Canada.
3. Provision of numerical weather map analyses and prognoses and related derived fields through the use of electronic computers.
4. Testing, evaluation and development of new operational analytical and prognostic weather map techniques for use in the Central Analysis Office and Canadian Forecast Offices.
5. Operation of a National Facsimile Transmitting Centre serving all stations on the Canadian Weatherfax System and also making transmissions to the American High Level Facsimile circuit from the Canadian High Level Centre.

ANALYSIS AND PROGNOSIS

1. Provision of weather map analyses and prognoses, and analysis and prognostic advisories, for dissemination by facsimile and teletype to civil and military meteorological establishments in Canada.

EXTENDED FORECAST

1. Provision of Extended Period Forecast Service in Canada.
2. Development and testing of Extended Period Forecast techniques.

OPERATIONAL DEVELOPMENT AND EVALUATION

1. Development, evaluation and testing of new operational analytical and prognostic weather map techniques, including numerical weather prediction methods for use in the Central Analysis Office and Canadian Forecast Offices.
2. Training of meteorologists newly assigned to the Central Analysis Office; and training of current staff in new methods.

COMPUTING SERVICES

1. Provision of numerical weather map analyses and prognoses and related derived fields, through the use of electronic computers.
2. Development and testing of computational techniques necessary for the solution of the mathematical and physical equations basic to numerical weather predictions.
3. Provision of computer and data processing services as required within the Central Analysis Office and to other sections and divisions within the Meteorological Branch.

PLOTTING

1. Provision of plotting services in support of analysis and prognosis program and for transmission to the Canadian Weatherfax System.
2. Provision of Charts for Canadian Weather Map Archives.

COMMUNICATIONS

1. Operation of a Teletype Receiving Centre for collection of northern hemisphere weather observations.
2. Operation of a National Facsimile Transmitting Centre serving all stations on the Canadian Weatherfax System, and also making transmissions to the American High Level Facsimile Circuit from the Canadian High Level Centre.

PROFESSIONAL TRAINING

1. Post-graduate lecture and laboratory programmes to qualify university graduates as forecasters.
2. Post-graduate lecture and laboratory programmes to further the professional development and potential of practicing forecasters.
3. Applied research programmes to evaluate and develop forecasting techniques and procedures for use in the Canadian Weather Service Forecasting System.
4. Management and scientific consultant services for those meteorological training programmes which are controlled by agencies outside the Research and Training Division, including the Air Services Training School and the Federal Electric School, Streator, Illinois.
5. Meteorological Branch Technical Publications including editorial functions and management of review functions.
6. Meteorological Branch Audio Visual Aids.
7. Academic evaluation and interviewing of university graduates for Meteorological Branch professional staff recruiting.

TECHNICAL SUPPORT

1. Meteorological observing programme.
2. Plotting of current and special weather maps and charts for use in the map analysis programmes.
3. Preparation and reproduction of maps, diagrams and charts for use in training and research programmes.
4. Preparation of data (maps, charts, diagrams, tables) to assist Training Section Meteorologists.
5. Operational assistance in support of an Analysis and Prognosis programme.
6. Preparation of training aids and special training materials.

TECHNICAL TRAINING

1. Management and scientific consultant services for meteorological technical training programmes at the Air Services Training School and Federal Electric School, Streator, Illinois.
2. Liaison with Regional management concerning meteorological technical training programmes.

TECHNICAL PUBLICATIONS

1. Editorial and review process for scientific and technical manuscripts, submitted by Meteorological Branch staff, including recommendations concerning medium of publication, i.e. Technical Circular, Meteorological Memoir or International Scientific Journal.
2. Proof-reading and preparation of manuscript for publication.

COURSE TRAINING

1. Lecture and laboratory instruction to the two-year M.Sc. programme in Meteorology, University of Toronto.
2. Administration and conduct of the post-graduate Meteorological Officer training programme.
3. Advanced Forecasting lecture and laboratory instruction for Meteorological Officer and Meteorologist students.
4. Analysis of current maps and presentation of current map discussions to training courses and Headquarters personnel.
5. Academic evaluation, advice and assistance in professional recruiting programmes.
6. Initiation, development and review of technical and training circulars.
7. Participation in scientific development and field training programmes of the Training Section.

SCIENTIFIC DEVELOPMENT AND EVALUATION

1. Applied research on operational forecasting problems.
2. Development and Evaluation of forecasting techniques and procedures for use in the Canadian Weather Service Forecasting System.
3. Initiation, development and review of technical circulars.

FIELD TRAINING

1. Lecture programmes and Forecasting Workshops for practicing forecasters, given at field offices.
2. Refresher courses for practicing forecasters, given at Headquarters.
3. Correspondence courses for field personnel.
4. Initiation, development and review of technical and training circulars.
5. Participation in scientific development and course training programmes of the Training Section.

AUDIO VISUAL AIDS

1. Selection and purchase of slides, films and audio visual equipment.
2. Lending of slides, films and audio visual equipment to Meteorological Branch staff for use in training programmes and public information and education.
3. Cataloguing, inspection, maintenance and storage of slides, films and audio visual equipment.

FEB - 1968

INSTRUMENT DIVISION

INSTRUMENT DIVISION

Provision and maintenance of meteorological instruments used by the Department of Transport and by National Defence.

PROCUREMENT AND MAINTENANCE

1. In coordination with the Users and Stores, determine and implement the optimum Branch procurement program for the provision of the correct types and quantities of instruments and the stocking and distribution of ancillary and spare parts.
2. Provide formal specifications and drawings for the procurement of instruments.
3. Prepare requisitions, evaluate tenders and generally expedite the purchase of instruments in coordination with the C.P.C.S.
4. Conduct or assure the inspection of instruments and equipment purchased for the Branch or constructed or calibrated within the Branch.
5. Provide information through catalogue, manuals and correspondence to facilitate the requisitioning and operation of instruments by the Users in the Department and in National Defence and to the general public, as applicable.
6. Authorize issue of certain categories of equipment.
7. Operate a Headquarters Installation and Maintenance Unit.

SPECIFICATIONS, DRAFTING, INSPECTION AND PROCUREMENT

1. Prepare final and formal specifications for instruments.
2. Prepare final mechanical drawings. The detail covered by the drawings will depend upon the procurement. This unit will also be charged with the necessary drawings required in the preparation of operational and maintenance manuals of instruments.
3. Arrange ahd carry out inspections as required by the specifications. These inspections will be carried out both during manufacture and after receipt of the instruments. Arrange for calibration by the calibration unit when appropriate.
4. Carry out the necessary liaison and contact with manufacturers and suppliers in connection with procurement and specifications.
5. Examine tenders and confer with the R & D Section and other Divisions on the technical and financial implications so that a recommendation may be supplied to the GPA on procurement.
6. Prepare requisitions for procurement of certain instruments. This will include the necessary technical information, precise requirements as regards to numbers, suggestions for inclusion of penalty clauses in purchase contracts, etc. The number of instruments to be ordered will be determined in consultation with the other user Divisions and after evaluation of the general supply situation in the Branch.

MAINTENANCE

1. Carry out or arrange for basic Headquarters overhaul on all types of equipment. This will include electronic mechanical, electrical instruments.
2. Instruct field personnel such as Meteorological Inspectors, selected radiosonde operators, Telecommunications personnel, etc., in maintenance techniques.
3. Establish a schedule of basic spares to be maintained in connection with various types of equipment.
4. Provide necessary manuals and instructions covering the maintenance of instruments and distribution to the field together with necessary amendments.
5. Prepare specifications for a standard installation. Provide advice on the procurement of the necessary hardware, including cables.
6. Install the instruments and carry out the necessary hook up to power and signal cables. Check out the instruments to commissioning.

CARPENTER SHOP

Wooden construction activities including shipping boxes and crates.

CATALOGUING AND RECORDS

1. Prepare and maintain illustrated catalogues and circulars specifying issue procedures.
2. Maintain records on authorizations, inventories and calibration cards.
3. Maintain library and circular facilities.
4. Prepare correspondence re the issue of instruments.

RESEARCH AND DEVELOPMENT

1. In coordination with the Users, evaluate the requirements for meteorological instruments and instrument services of the various programs of the Department and for National Defence activities.
2. Investigate and determine the optimum means for fulfilling the instrumentation requirements of the programs. This will involve surveys of the appropriate scientific and commercial literature; the testing and evaluation of instrument performance under laboratory and field research projects within the Branch or by outside agencies.
3. Act as the Branch technical and design authority for instrument procurement. This will involve the provision of the technical information required for specifications and drawings; the provision of technical standards for acceptance inspection and quality control procedures and the technical evaluation of tenders; the provision of design assistance to the Instrument Shop on production matters.
4. Provide assistance in the procurement, installation and maintenance or specialized instrumentation used in research projects. This will involve the training of project personnel in the operation and maintenance of instrument systems and the provision of maintenance support to ensure the operation of complex equipment.
5. Investigate new techniques and fundamental improvements in instrumentation and observation methods.
6. Provide sceintific and technical competence in the field of meteorological instrumentation through recruiting and developing personnel, maintaining a technical library and through liaison with industry, scientific organizations, Government Departments and foreign Meteorological Services.
7. Maintain and operate Laboratory, Calibration and Model Shop facilities.
8. Prepare scientific reports and instrument manuals and circulars; give instrument lectures and serve as Branch representative on W.M.O. and other scientific committees, as required.
9. Provide information to other Government agencies and to the public on the technical aspects of meteorological instruments.

SURFACE INSTRUMENT UNIT

1. Fulfill the Section's research and development responsibilities for instruments used near the earth's surface.
2. Evaluate and recommend improvements in instruments and instrumental methods in established programmes and networks.
3. Make recommendations for the optimum instrumentation of new programmes.
4. Co-ordinate the supporting work of the other Units and Sections of the Instrument Division in the development, and evaluation of surface instruments.

- SYNOPTIC AND AIRWAYS NETWORKS
- CLIMATOLOGICAL AND OTHER NETWORKS
- CLIMATOLOGICAL RESEARCH
- MECHANICAL DESIGN

THE UPPER AIR & ELECTRONICS UNIT

1. Fulfill the Section's research and development responsibilities for instruments used in upper air measurements, or for instruments which are mainly electronic in nature
2. Evaluate and recommend improvements in instrumentation in established programmes and networks.
3. Make recommendations for the optimum instrumentation of new programmes.
4. Co-ordinate the supporting work of the other units of the Instrument Division, in the development & evaluation of upper air instruments and meteorological instruments with complex electronic content.
5. Arrange for the support of the Telecommunications & Electronics Branch, as required, in instrument development & evaluation.

- METEOROLOGICAL RADAR
- OPTO ELECTRONICS: Electronic support.
- UPPER AIR: Upper Air instrumentation.
- AUTOMATIC OBSERVING: Automatic Data Sensing, recording and transmission.

CALIBRATION UNIT

1. Specify, install, operate and maintain calibration standards and facilities.
2. Calibrate all types of meteorological instruments and issue Calibration Certificates. This activity will be in support of field operations, research activities and meteorological instrument procurement.
3. Provide calibration and test facilities for use in the development and testing of new instruments or components.
4. Perform mechanical and electrical adjustments where necessary to bring instruments into calibration tolerance when required.
5. Fabricate or requisition jigs, fixtures and accessories required in the calibration of instruments.
6. Maintain and operate a Development Shop for fabrication and repair of calibration equipment and for the construction of experimental instruments or apparatus required for the development and evaluation of meteorological instruments.

LABORATORY

1. Production calibration.
2. Experimentation.
3. Standards.

UNIT SHOP

1. Fabrication of laboratory apparatus, special and prototype instrumentation.
2. Maintenance of shop facilities.

RESEARCH PROJECT INSTRUMENTATION UNIT

Fulfill the section's responsibilities for instruments and instrument systems on assigned Branch research programs.

FIELD TEST UNIT

1. Test and evaluate standard meteorological instruments under field conditions to determine accuracy, reliability, maintenance procedures, etc.
2. Test and evaluate prototype instruments under field conditions.
3. Compare meteorological instruments to determine the accuracy and consistency of a number of similar instruments as well as intercomparison of instruments used to measure the same parameter but of a different design.
4. Prepare reports on tests.

GENERAL ADMINISTRATION

1. Coordination of division activities arising from policy decisions.
2. Prepare documentation and coordinate plans and projects involving several sections of Instrument Division.
3. Coordinate the preparation of the Instrument Division annual estimates.
4. Coordinate the job costing activities of the various sections and arrange for management investigations as required.
5. Coordinate personnel matters of the Division.
6. Provide Secretarial services for inter Divisional meetings.
7. Assemble and edit monthly reports.
8. Set up and manage normal office routines and other related administrative matters.

INSTRUMENT SHOP

1. Construct certain meteorological instruments and components as required by the Branch and the Department of National Defence. This will include experimental models, prototypes, minor production runs and other work that it is not economical to obtain from outside industry.
2. Recondition and repair mechanical and electro-mechanical instruments returned from operational and research programs,
3. Assist the Research and Development Section staff in the design and evaluation of meteorological instruments.
4. Design and provide specialized tools and fixtures for the production and overhaul of meteorological instruments as required.
5. Prepare cost estimates, maintain production records, and to requisition materials, supplies and services as required.
6. Recommend and maintain the staff and facilities required to carry out these responsibilities.

[illegible]

1. Maintain job-time and general records.
2. Prepare draft requisitions for materials and supplies.

MECHANICAL

Fabricate, assemble and repair instruments and components of a mechanical nature.

ELECTRICAL

Fabricate, assemble and repair instruments and components of an electrical nature including units with elementary electrical circuits

REPAIR

Assess for the purpose of repair plant stock instruments. Carry out and/or arrange for the repair of plant stock instruments in co-operation with the mechanical and electrical sections

PROTOTYPES AND EXPERIMENTAL CONSTRUCTION

Construct prototype-instruments.

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BASIC WEATHER DIVISION

Provision of:

1. A Canada-wide meteorological data acquisition system composed of observations of meteorological elements in temperate and arctic areas at the surface, in the upper atmosphere, both land and marine, as well as allied specialized observations.
2. Establishment of procedures and standards for all meteorological observations and associated inspection services.
3. Observations of ice for Canadian coastal waters and inland waterways.
4. Liaison with other government departments involving other cooperative scientific observational programmes.
5. Liaison as appropriate with foreign meteorological services or agencies concerning meteorological and associated observations.

SURFACE SECTION

1. Directs and manages the Surface Section.
2. Directs the control, establishment and the administration of standards for installation, inspection and observation of all surface land observing programmes throughout Canada.
3. Directs the operational testing and network development of advanced instrumental systems for surface weather observations.
4. Directs the development, control and administration of standards of Canada's participation in the International Surface Meteorological Weather Observing programme on ships which operate on the Oceans of the world, Canadian Coastal and Inland waterways.
5. Directs and co-ordinates the preparation of the budget and the 3-year plan and 10-year forecast of capital needs for the Surface Section.
6. Directs the assessments and recommendations on capital, operating, and personnel estimates and requirements from Air Services Regions connected with Surface Observing programmes, related equipment and facilities.
7. Directs the management of the ice observing programme of ice congested waters for inland and coastal waters of Canada

TECHNICAL OPERATION AND INSPECTION

1. Directs and manages the Technical Operation and Inspection Unit
2. Develops, controls, and administers observing standards, practices and procedures for land surface observing programmes throughout Canada.
3. Establishes standards, practices and procedures for land surface meteorological inspection, installation and field maintenance
4. Develops and maintains standards for the control of planning and phasing, establishment of surface weather stations and related projects.
5. Co-ordinates and participates in the preparation of budget and 3-year plan and 10-year forecast of capital needs for the Technical Operations and Inspection Unit, the Surface Section and the Basic Weather Division.
6. Assesses and recommends on capital, operating and personnel estimates and requirements from Air Services Regions surface observing programs, related equipment and facilities
7. Represents the Basic Weather Division on Branch (H.Q.) financial implementation team
8. Provides staff support on matters related to Regional and National Surface Observational Services to the Superintendent of Surface Weather, deputizes for him in his absence and performs related duties

TECHNICAL OPERATIONS

1. Recommends, develops, and prepares standards on matters relating to the Canada-wide programme for removing, resiting and expanding meteorological observations and equipment at primary stations
2. Assists in the planning and guidance for the implementation of special parameter networks.
3. Liaises with other Meteorological Branch Divisions on matters arising from the technical operations of surface observing programmes
4. Assists in the reviewing of the operational plans for meteorological facilities connected with surface observation services
5. Monitors special projects designed to assess the operational capability of the equipment as well as suitability of the autographic record.
6. Attains and maintains standards to meet the [illegible]
7. Co-ordinates the requirements for meteorological instruments and equipment on a Canada-wide basis
8. Arranges for the translation and printing in French of Meteorological instructions and forms relating to surface observational programmes
9. Assists in the preparation and compilation of the budget estimates, and long-range plans for the Basic Weather Division.
10. Attends committee meetings to represent Basic Weather Division

SURFACE OBSERVING STANDARDS

1. Supervises the programme for the maintenance of observing standards for national surface weather programmes including pilot balloon observations, radioactive sampling and observations of noctilucent cloud, evaporation and visual aurora
2. Prepares and amends manuals and circulars for meteorological observing standards, practices and procedures
3. Co-ordinates and adjusts standard practices and procedures of weather observing and reporting, as adopted by the Canadian Meteorological Service, with WMO Technical Regulations.
4. Produces appropriate summaries and advisories, suggesting corrective action to ensure conformity with established standards of observing and reporting
5. Recommends development of policies and standards affecting weather observing procedures
6. Co-ordinates with other Divisions in revising current forms and in designing new forms to provide the most efficient presentation of observed data.
7. Supervises the continuous review of Headquarters monitoring of surface weather observations including a critical review of the output of data control computers and technicians.
8. Liaises with other Divisions on observing and recording procedures.
9. Serves on committees concerned with weather observing practices and procedures

INSPECTION

1. Manages, co-ordinates, and directs, the surface weather inspection unit.
2. Controls the inspection of surface weather facilities on the DEW line.
3. Develops policy standards, practices and procedures for the inspection of surface weather programmes on a national basis.
4. Provides special advice to Regional Inspection Staff on inspection techniques and policies.
5. Co-ordinates with other Divisions for the provision of relevant station information, and maintains a comprehensive stations directory for research purposes.
6. Plans conferences, workshops and training courses for inspection staff as required.
7. Develops inspection manuals and reports for record purposes
8. Ensures that inspection reports are critically reviewed for content and format and that appropriate remedial action is taken when necessary.
9. Evaluates staff and arranges for replacement personnel as required.

DEVELOPMENT AND SUSTAINING SERVICES

1. Plans, co-ordinates, and supervises the operational testing, network development, and operational employment of advanced instrumental systems for surface weather observing
2. Supervises the operation and development of the networks for the observation of solar and terrestrial radiation, and of atmospheric ozone.
3. Develops standards for the siting and exposure of instruments and facilities and co-ordinates their application with Regional and Departmental agencies.
4. Provides meteorological input to Airport Master Plans in co-ordination with Regional and Departmental agencies.
5. Supervises the operation of the weather surveillance radars and co-ordinates with other Divisions on the development of the radar network.
6. Maintains the required standards for barometric pressure observations, including computation and distribution of station correction and reduction tables, records calibrations and comparisons of station inspection, and standard barometers, continued review of the pressure observing programmes
7. Supervises assignments of identifiers and index numbers to weather stations, and other facilities, including the maintenance of records of assignments, and the compiling, printing, distribution and amendment of necessary reference publications.
8. Supervises the maintenance of continuous detailed records of the location and observing programmes of weather stations, and the compiling, printing, distribution and amendment of necessary reference publications
9. Supervises the payment of observing allowances to part-time weather observers and prepares and submits periodic revisions in the scales of payment.

RADIATION AND OZONE NETWORK

1. Management and development of the network of solar radiation observations, both surface and upper air, including internal co-ordination with other Sections and Divisions, Air Services Regions and agencies in the implementation of the programme.
2. Management and development of the network of surface and upper air ozone observations, including co-ordination with other Divisions, Air Services Regions in the implementation of the programme
3. Co-ordination with other Divisions and Air Services Regions in instrument procurement, installation and re-supply for the solar radiation and ozone observing programme.
4. Supervision of the training of observing personnel for the solar radiation and ozone programme
5. Co-ordination with other Divisions and Air Services Regions in the inspection and maintenance of solar radiation and ozone instrumentation
6. Preparation and revision of instruction manuals and circulars pertaining to the operation of the solar radiation and ozone observing networks.

WATER AND ICE

1. General supervision of the marine meteorological observing programme and services to ships and the operation of the ice observing programme in all its phases
2. Development of procedures and standards for marine and ice observations and ice thickness measurements.
3. Development of new and improved ice observing technique and improved equipment to furnish information to meet existing and future demands for ice information
4. To assess new developments in radar, microwave radiometry and aerial navigation equipment for applicability and feasibility in aerial ice observing.
5. Development of specifications for observer positions on suitable types of aircraft for ice observation and specialised instrumentation including latest type of precision navigation equipment.
6. Negotiation and administration of contracts for ice observation aircraft
7. General supervision of the A.P.T. Programme for operational purposes in acquiring ice data.
8. General supervision and participation in training courses for ice observers and marine weather observer courses, including field refresher training for ice observing and maintenance of observing standards.
9. Liaison with Government Departments and other Branches and foreign agencies as appropriate within the above functions.
10. General supervision of the preparation of technical reports and recommendations for submission as appropriate to WMO.
11. General supervision of the publication of observed ice data and developing improved system for recording data adaptable to machine methods.
12. To be responsible for authorized financial management of the programmes.

MARINE

1. Supervises Canada's participation in the International weather observing programme on ships operating on the high seas, Canadian coastal waters and the Great Lakes
2. Co-ordinates activities of Port Meteorological Officers.
3. Arranges for the provision of suitable meteorological instruments, instructions manuals, stationery items, and other observing aids to weather reporting vessels.
4. Supervises a programme of quality control and processing of ships' weather records, in co-operation with the Climatology Division
5. Serves as a member of the CMM Working Group on Technical Problems, and as Basic Weather representative on certain Headquarters committees.
6. Co-ordinates provision of meteorological equipment and services to nautical schools and examiners of masters and mates.
7. Supervises programmes for the reporting of freeze-up and break-up of ice, and the reporting of water temperature on inland waters.
8. Provides and interprets information on marine weather conditions and climatological data for private and public agencies.

I C E

1. Provides functional control, under general supervision for the unit and ice observing programme.
2. Supervises, inspects, and maintains standards of all aspects of the ice observing programme including aerial, shipboard, shore station and ice thickness.
3. Plans and carries out formal course, on the job and refresher training.
4. Recommends and evaluates the development of new ice observing techniques, procedures, aids and equipment.
5. Preparation and distribution of operational directives, manuals, ice circulars and publications of observed ice conditions.
6. Supervises operational liaison with other Divisions, Regions, Branches, Ice Operations Offices, and air carriers insofar as the ice observing programme.

ARCTIC

1. Direction and administration of the Joint Canada/United States Arctic Observatories and other scientific activities associated with the Joint Observing Programme.
2. Co-ordination with other Canadian Government departments and Agencies and with the U.S. Weather Bureau the scientific programmes and activities.
3. Liaison with various scientific agencies and other organizations using the Arctic Observatories as advanced bases or scientific platforms for their operations.
4. Direction of the preparation of studies of a scientific nature on Arctic Meteorology relative to the operation of stations in the high arctic
5. Co-ordination of the air and sea re-supply and special transportation to the Arctic Observatories and liaison with the RCAF, Commercial Air Carriers and Canadian Coast Guard as required.
6. Liaison with other Air Services Branches concerning support roles.
7. Direction of semi-annual inspection programme of all aspects of Arctic Observatories.
8. Development of proposals for new policies or changes to meet the expanding and changing requirements in the Arctic.
9. Preparation and review of proposals with reference to capital, operating and personnel estimates
10. To represent the Department on committees and working groups as required

Scientific and Technical Operations

1. Development, review and revision of detailed plans for scientific observations at the Joint Arctic Weather Stations; organising and supervising the scientific programmes
2. Liaison with other agencies, both Canadian and United States, concerning proposals for additional scientific programmes and activities at the Joint Arctic Stations.
3. Conducting scientific investigations and activities, and preparation of reports.
4. Supervision and participation in the inspection of the Joint Arctic Observatories.
5. Acting as Officer-in-Charge of the Central Arctic Observatory and participating in forecast duty and briefing service at Resolute as required.
6. Serving on committees and working groups dealing with the Joint Arctic Weather Stations
7. Preparation and review of capital, operating and personnel estimates
8. Act for the superintendent in his absence.

Inspection and Station Procedures

1. Inspection of the Joint Arctic Weather Stations, installation, maintenance and servicing of meteorological instruments; assessment of technicians meteorological and preparation and review of efficiency reports on personnel engaged in meteorological observations both surface and upper air.
2. Clarification and interpretation of manuals on surface, upper air radiation and ozone observations to field staffs, and provision of further on-the-spot training of field staff as required.
3. Quality control of meteorological observations by monitoring and review of records and follow-up by further instruction to field staff.
4. Assessment of work load at the Joint Arctic Weather Stations. Development and review of work rosters for the efficient discharge of the scientific programmes, assessment, amendment and review of claims for overtime and initiates pay action for personnel of these stations.
5. Installation and periodic maintenance and modification of electrolytic hydrogen generators to bring up to CSA standards; instruction of field staff on the operation and running maintenance and servicing of this and other meteorological equipment.
6. Liaison with Upper Air Section and with Vancouver Region on the provision of replacement of upper air and surface observing staff; prepares transfers, estimates of removal expenses, travel advances and movement of official forms; arranges for provision of meteorological forms and replacement of meteorological equipment.
7. Acts as officer-in-charge of the Joint Arctic Weather Stations at Alert, Eureka, Isachsen and Mould Bay in emergency and on short notice.
8. Assists in the preparation of preliminary capital, operating and personnel estimates; assists in coding and recording of costs.

Financial Planning and Special Assignments

1. Prepares agendas, supporting documents and minutes of meetings with outside agencies affecting the Joint Arctic Weather Stations.
2. Prepares detailed estimates and revisions as required on capital, operating and personnel for the Arctic Section and the Joint Arctic Weather Stations
3. Prepares detailed reports on special programmes assigned to the field stations.
4. Coordinates and liaises with other scientific agencies making use of the facilities of the Arctic Stations as field bases.
5. Acts on committees and working groups as required

Development and Support Services

1. Development and supervision of the supporting services necessary for the efficient operation of the Arctic Observatories.
2. Operational liaison with officials of the RCAF, Civil Air Carriers, Canadian Coast Guard and U.S. Weather Bureau in connection with the re-supply of the Joint Arctic Observations. Preparation of specifications and draft contracts for commercial airlift.
3. Liaison with other Branches of Air Services concerning planning, construction and maintenance of buildings and ancillary structures, and development and maintenance of airstrips; liaison with Regional Offices on resupply of specialized staff.
4. Coordination with manufacturers and suppliers of specialized equipment.
5. Assists in the annual field inspection of the Joint Arctic Weather Stations, preparation of detailed reports relating to logistics, resupply, and condition of buildings, facilities and airstrips
6. Maintenance of records required to facilitate the flow of supplies and equipment and the exchange of personnel.
7. Special assignments related to the operation of the Joint Arctic Observatories
8. Assisting in the preparation of proposals on capital, operating and personnel estimates; maintenance of records of running costs of the stations by resource.

Supplies and Equipment

1. Ordering, arrangements for shipping, handling, development, caching, and airlift of the supplies, materials and equipment for the annual and periodic resupply of the Joint Arctic Weather Stations
2. Operational liaison with other Divisions of the Branch, manufacturers, Canadian Coast Guard, U.S. Weather Bureau, and Regional Office in connection with the above duties.
3. Arranging for replacement of personnel, transport, preparation of transfers, personal interviews, travel advances and movement of official.
4. Maintenance of inventories of supplies and equipment at field sites as required in connection with resupply; records of costs of field operations by station and resource.
5. Field trips to Montreal, Resolute and Thule to coordinate arrangements for shipping, caching and airlift of supplies and equipment; field arrangements for transport of personnel; detailed reports on logistics and arrangements for resupply.
6. Provides data required in the preparation of estimates of costs of commercial airlift and operation of the Joint Arctic Stations.

PROPERTY, BUILDINGS AND AIRSTRIPS

1. Planning and arranging for improvements to existing buildings, water supply, sanitation, roads and airstrips, and fire prevention.
2. Study of and solution of special stabilization problems in connection with buildings, airstrips and facilities in severe climates and built on permafrost
3. Planning and liaison for improvements to heating systems, protection of water supply from frost, maintenance of freezers, maintenance of electrical power systems and standby electric generators.
4. Planning maintenance, replacement or expansion of storage facilities, dormitories, operations buildings, electrical power houses and specialised buildings to meet operational demands.
5. Arranging for marking of roads, runways, pipelines, power cables and for land reservations at the field sites for winter arctic operations.
6. Coordination of the above projects at the appropriate level with Regional Office and representing the Branch as required.

BASIC WEATHER DIVISION

Provision of:

1. A Canada-wide meteorological data acquisition system composed of observations of meteorological elements in temperate and arctic areas at the surface, in the upper atmosphere, both land and marine, as well as allied specialized observations.
2. Establishment of procedures and standards for all meteorological observations and associated inspection services
3. Observations of ice for Canadian coastal waters and inland waterways.
4. Liaison with other government departments involving other cooperative scientific observational programmes.
5. Liaison as appropriate with foreign meteorological services or agencies concerning meteorological and associated observations.

UPPER AIR

1. Direction and co-ordination of upper air programmes at upper air stations.
2. Direction of upper air programmes in support of specialized atmospheric studies and research projects.
3. Development of new or improved operating techniques and procedures.
4. Direction of programmes of development of new or improved balloons and related materials and techniques including generation of hydrogen, balloon conditioning and similar items.
5. Direction of operational testing of new or improved observing systems, schedules and other requirements
6. Direction of programmes for personnel upper air training and quality control through record checking.
7. Direction of preparation of technical manuals, operational guidelines and field directives.
8. Direction of operational responsibility for the seismological, ozone and radiation programmes at selected upper air stations in co-ordination with the appropriate Department or Division respectively.
9. Direction of upper air station installation programmes and the planning and co-ordination of field inspection services
10. Preparation of proposals for upper air with reference to capital, operating and personnel estimates and budgets and assessment and recommendation concerning regional submissions
11. Development of proposals for new policy or changes to existing policy.
12. Co-ordination and planning with other Government Departments for specialized scientific observational programmes adaptable to the facilities and capabilities of upper air stations.

DEVELOPMENT AND INSPECTION

1. Planning and coordinating the continuous physical improvement of the network of upper air stations including technical installations, operational buildings and sites
2. Investigation and development of new equipment and techniques for increasing the efficiency of upper air stations including hydrogen generating and balloon inflation systems
3. Planning and coordinating the upper air technical inspection programme to ensure adequacy of facilities and conformance with established standards and policies.
4. Organizing and directing special upper air programmes at various temporary sites in support of research projects conducted by the Meteorological Branch in such fields as precipitation physics, hail studies, and air pollution.
5. Provides professional consultation on upper air technical installations, hydrogen equipment and balloons to Department of National Defence and other government departments and other agencies and individuals requesting advice in these fields
6. Technical surveillance of rawinsonde and other meteorological equipment used at the upper air stations to ensure satisfactory operation. This involves conducting investigations into malfunctions of such equipment and undertaking appropriate corrective action, frequently through liaison with the Instrument Division and Regional Offices
7. Act for the Superintendent in his absence.

SPECIAL PROJECTS

1. Manages rawinsonde programmes at temporary sites in support of research projects
2. Manages tethersonde observational programmes at temporary sites in support of research projects
3. Develops improved techniques for making tethersonde observations and drafts the instructions for making tethersonde observations
4. Instructs observers in tethersonde observations.
5. Compiles statistical data from upper air records in support of special investigations into the performance of field equipment and into the technical suitability of existing and proposed upper air sites.

TECHNICAL INSTALLATIONS AND INVESTIGATIONS

1. Conducts a continuing programme of improving hydrogen generating systems used at upper air stations by means of coordinating the supply and installation of new hydrogen equipment, writing operating and maintenance instructions, and providing advice and assistance in correcting problems as required.
2. Carries out investigations of performance of radiosonde flight equipment and ancillary electronic ground equipment through studies of reports submitted by the field stations.
3. Conducts evaluation tests on various new types of aerological balloons to provide a technical basis for decisions on procurement.
4. Carries out development projects on equipment used in balloon inflation, conditioning and release and on other non-instrumental radiosonde equipment
5. Conducts safety investigations designed to eliminate potential hazards at upper air stations, particularly those connected with the use of hydrogen.

OPERATIONS & MANAGEMENT

1. Administration in co-ordination with Regional Offices and within Meteorological Headquarters of the pool of upper air observers including Officers-in-Charge, maintenance Technicians, Technicians for specialized projects with respect to recruiting and selection of personnel, staffing of stations (postings and transfer) performance evaluations, promotions, refresher training
2. Development and improvement, through appropriate controls, of standards of performance involving analysis of station operational performance by statistical methods to promote greater efficiency.
3. Control of standards and promotion of efficiency through an established error-count and review systems combined with communication of corrective instructions.
4. Developing improved working procedures and determining technical work loads to conform to improvements in equipment design and changes in observational requirements.
5. Preparation and revision of circulars and technical manuals on upper air operations and procedures
6. To assess requirements for expendable and certain non-expendable supplies in co-ordination with Regional offices and within Meteorological Headquarters; to prepare operational specifications on various radiosonde expendables and associated supplies.
7. To provide technical advice on operational requirements and specifications of expendable and non-expendable materials and supplies.
8. To carry out liaison between Regional Offices and Meteorological Headquarters in regard to Upper Air station supplies to conform to established guide lines in regard to decentralization of Departmental Organization relating to the operation of Upper Air stations.
9. Co-ordination of the operational responsibility for seismological, ozone and radiation programmes at selected Upper Air stations with appropriate Departments or Divisions respectively

OPERATIONAL STANDARDS & PERFORMANCE

1. Maintenance of observing standards and determination of technical performance of observers through detailed analysis and evaluation of upper air records and climatological error count summaries, writing reports and conducting appropriate follow-up correspondence to the field
2. Assists in making time studies of various phases of upper air observations and in assessing work loads at upper air stations
3. Assists in appraising the techniques and procedures used in upper air observations in order to improve the operational efficiency of the personnel and of the upper air equipment
4. Assists in arrangements for the movement of upper air personnel on transfers, for annual leave, temporary duty and in arrangements for the provision of expendable materials and supplies for upper air stations.
5. Assists in writing circulars and amendments to manuals, in writing reports on upper air operations and maintenance of observing standards, and in revising meteorological forms.
6. Assists in research and development work to test and improve the quality of upper air equipment such as batteries, radiosondes and balloons, wind plotting apparatus etc.

FIELD OPERATIONS

1. Coordinates and arranges with the Regional Offices, and with Meteorological Headquarters the staffing of Upper Air Stations including deployment of staff, reviewing and preparation of transfers, providing directives and instructions on movement of personnel etc.
2. Plans and coordinates with the Regional Offices and with the Stores Section the provision of expendable material and equipment to upper air stations including monitoring requisitions, preparation of estimates of annual requirements, provide advice on cargo bookings for annual shipment of meteorological supplies, reviewing tenders for balloons and chemicals etc.
3. Assisting in the preparation of guidelines and special instructions to the Regional Offices regarding budgeting and regulations and shipment of supplies to upper air stations.
4. Preparation of circulars and letters of instruction to the field on requisitioning, reporting and maintaining supplies, transfers and leave arrangements etc.
5. Developing and organizing procedures to improve the efficiency of stations regarding supplies and personnel and carrying out special assignments on defective equipment or supplies.
6. Participation on rating and interview boards and advisory councils

TRAINING AND RECORDS

1. Supervision of instruction and training of personnel in all phases of upper air observations including the operating techniques of the electronic equipment, methods of calculating, plotting and coding of upper air data as well as proper procedures for safe hydrogen manufacture and balloon inflation and release
2. Supervision of extended practical training in surface weather observing during upper air training and special training in other scientific observations such as seismology, ozone and radiation.
3. Planning and supervising the preparation of syllabi and lecture material for complete upper air training. Preparation of circulars and manuals pertaining to upper air observations and techniques.
4. Maintains quality control through a system of checking computational records from upper air stations and preparation of detailed reviews and corrective criticisms.
5. Supervision of preparation and marking of upper air qualifying examinations.
6. Development of improved observational techniques applicable to various phases of the upper air program.
7. Co-ordinating the functions and program of the Upper Air Training School through participation on committees and working groups involved in matters of Staff Training, Syllabi, Training Circulars and Procedures.
8. Provides good public relations through lecture tours of the establishment particularly to regular groups of secondary school students in the interests of promoting the science of meteorology as a career.

RECORDS & QUALITY CONTROL

1. Checking of field records for correct procedures and accuracy of computations
2. Preparation of detailed reviews and corrective instructions for distribution to Regional offices and station personnel.
3. Development of new procedures and techniques applicable to various phases of upper air observing
4. Preparation of circulars and manuals e.g. Manupp, pertaining to upper air observations and techniques.
5. Conduct testing of equipment and research projects assigned to the training and records unit.

TRAINING

1. Conducting the training and development of syllabi, schedule training aids and lecture material for the training of personnel in all phases of upper air observing including the operating techniques of the electronic equipment methods of evaluating plotting and coding of upper air data as well as proper procedures for safe hydrogen generation and balloon inflation and release.
2. Conducting special training in scientific observations such as seismology, ozone and radiation.
3. Conducting special courses for upper air inspectors and upper air officers-in-charge.
4. Preparing and marking upper air tests and qualifying examinations and assessing trainees.
5. Assessing new equipment for operational use.
6. Maintaining the upper air training school equipment
7. Act for the supervisor in his absence.

HIGH ATMOSPHERIC VEHICLES

1. Development of a Canadian programme of systematic high atmospheric meteorological soundings initially using rocketsonde techniques
2. Participation in and assessment of existing experimental high atmospheric soundings.
3. Preparation of specifications for rocketsonde systems and associated support equipment.
4. Preparation of personnel estimates and the budget and 5-year plan and 10-year forecast of capital requirements for High Atmospheric Vehicles Section.
5. Direction of personnel training with respect to rocketsonde programme, and establishment of techniques for quality control of data and preparation of associated manuals
6. Liaison with other Government Agencies, universities and industries associated with High Atmospheric soundings including Foreign Services
7. Continual studies of all literature and techniques applicable to high atmospheric soundings.
8. Participation in working groups and committees as appropriate.
9. Preparation of scientific papers, technical reports
10. Preparation of policy recommendations.

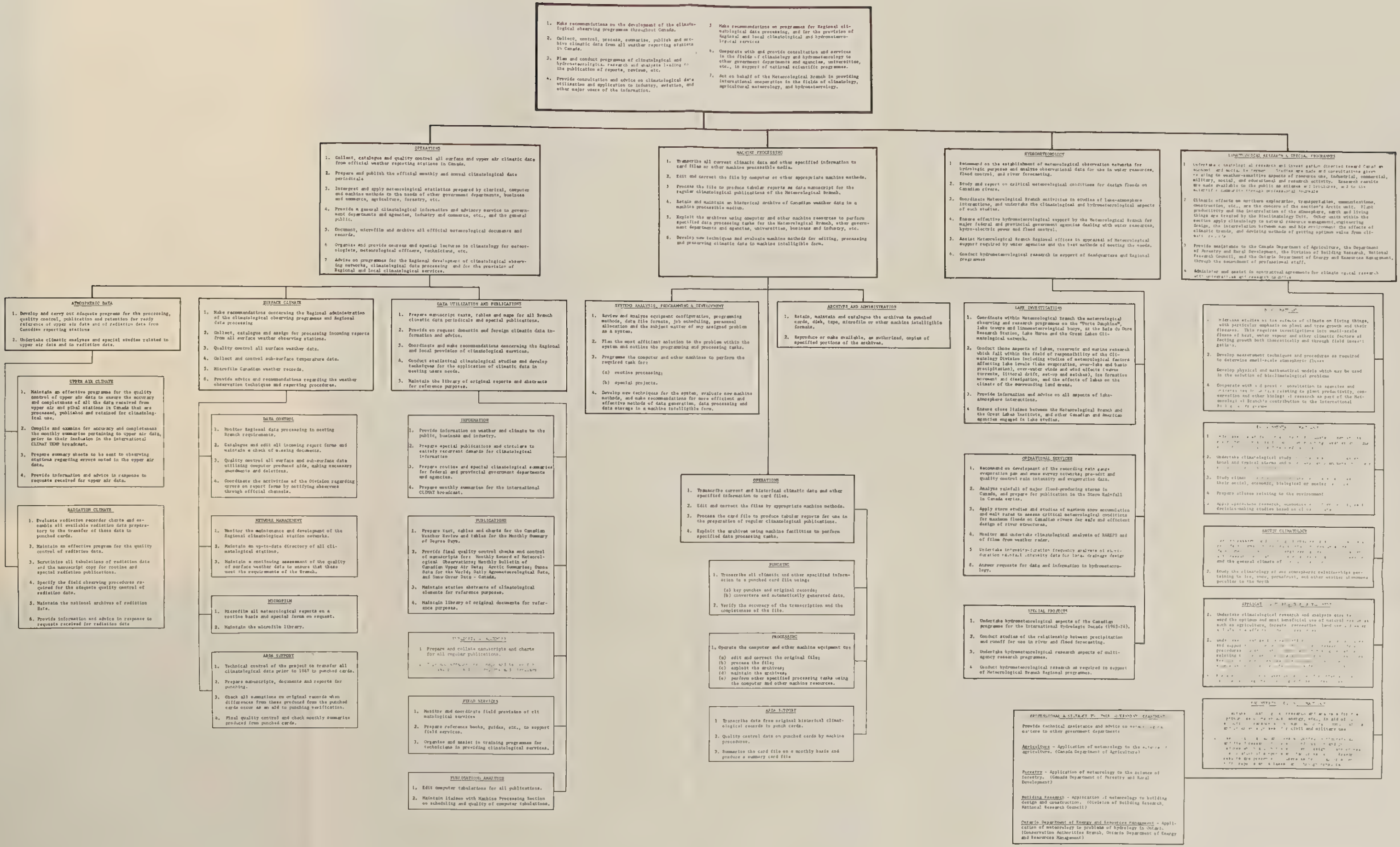
DATA REDUCTION AND TECHNICAL OPERATION

1. Responsible for the collection and reduction of raw meteorological data obtained from High Atmospheric Vehicle Field Stations and appropriate distribution of same.
2. Studies all literature on new techniques and developments in the field of data reduction and makes recommendations based on these studies.
3. Reviews and makes error analyses on raw rocketsonde data and institutes appropriate action to ensure maintenance of standard procedures
4. Maintains liaison with all organizations receiving data from the High Atmospheric Vehicle Section regarding the type and quality of data required.
5. Responsible for the training of station personnel in launch procedures, impact prediction and data acquisition.

OPERATIONS AND MANAGEMENT

1. Responsible for insuring that field stations adhere to established procedures of range operation with particular regard to range safety.
2. Directs and develops the supporting services necessary for the efficeint operation of High Atmospheric Vehicles stations
3. Responsible for personnel schedules including relocation and leave.
4. Maintains records required to facilitate the flow of supplies and specialized equipment and the exchange of personnel.
5. Maintains, updates and distributes operations and instruction manuals
6. Assists in the preparation of proposals on capital and personnel estimates.
7. Co-ordination with manufactures and suppliers of specialized equipment..

CLIMATOLOGY DIVISION



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ADMINISTRATION DIVISION

1. Advise the Director on (1) management and administrative matters in the provision of meteorological services to meet accepted Branch responsibilities (2) development of new plans and programmes or changes to existing policies and programmes to ensure adequacy of meteorological services for submission for A.D.M.A. consideration.
2. Overall management of Branch finances which involves (1) analysis of existing programmes (2) review of proposed changes and new items (3) determination of validity and priority for changes and new items (4) development of personnel and financial estimates (5) Branch representation in presentation of estimates to senior levels in the Department and to Treasury Board staff (6) detailed administration of approved budgets.
3. Plan, organize and direct the activities of the Administration Division which is responsible for Branch functions in the fields of finance and personnel; in the procurement, stocking and issuing of meteorological equipment and supplies; in the provision of office services, facilities and accommodation for Meteorological Branch Headquarters; and in the provision of meteorological library services.
4. Co-ordinate the plans of the operating Divisions and the Regions and advise other Division Chiefs and Regional Directors of acceptance, changes or any action needed.
5. Approve within the limits authorized by the Department, purchase requisitions, warrants and other financial documents.

PLANS AND BUDGET

1. Develop and implement systems and procedures (compatible with Departmental systems) for the preparation of the long range plan; prepare the long range plan from material submitted by Divisions and Region; recommend adjustments to plans to ensure internal consistency and overall conformity with current fiscal policies.
2. Instruct managers on the preparation of work plans and budgets and prepare financial and personnel main estimates of the Branch.
3. Prepare consolidated statement of training requirements of Branch Headquarters.
4. Within the framework of Departmental Systems, adapt and/or implement revenue accounting, cost accounting, estimating, forecasting and financial reporting systems and procedures for recording, controlling and forecasting expenditures and revenues of Branch Headquarters.
5. Carry out routine accounting functions including preparation of encumbrances and warrants, recording of expenditures for source document control and cash control, processing accounts payable and accounts receivable and auditing and processing of travel and removal claims.
6. Exercise budgetary control over all funds available to Branch Headquarters; analyse expenditure statements, budget variances and prepare consolidated variance report; recommend to managers appropriate action for the effective use of financial resources.
7. Advise and assist managers on financial matters by (a) providing routine advice on coding and interpretation of financial reports etc. (b) determining unit costs for establishing standards of performance (c) analysing trends in operating costs and revenues and recommending changes in rates of charge for Meteorological Service.

PERSONNEL

1. Advise the Director, Meteorological Branch, and line officers, on personnel policy, procedures and practices in such areas as staffing, training and development, classification, pay and conditions of service.
2. Review recommendations of line officers for adherence to departmental policies and practices, and develop and recommend changes in the personnel program where indicated.
3. Implement, direct and coordinate the departmental manpower planning, staffing and development program in the Meteorological Branch, consulting with line officers to establish current and long-range staffing and training needs.
4. Interpret and adapt departmental staff relations programs as determined for the Air Service.
5. Advise line officers on classification matters and direct analysis of jobs as required.
6. Direct the personnel staff at headquarters of the Meteorological Branch providing a mix of generalist and specialist talents, and a personnel records unit, to assist and advise managers in this headquarters in all matters of personnel administration.

OFFICE ARRANGEMENTS

1. Provide services associated with central registry, duplicating, distribution and mailing, office type composing machine services, inter-building transportation and intra-office messenger needs.
2. Inspect, review and schedule destruction of documents; maintain record of files transferred to inactive storage; obtain information from inactive files, arrange for material for archival preservation; arrange for microfilming of charts, maps and documents.
3. Maintain custody of manuals, pamphlets, circulars, etc., and authorizes sale of same, acting as agent for the Cdn. Govt. Printing Bureau; maintain stock control, authorize issue and arrange for replenishment or reprint action.
4. Co-ordinate accommodation requirements with D.P.W.; co-ordinate security liaison with R.C.M.P.
5. Control sales of meteorological instruments.
6. Meet Met. Branch printing requirements within the capabilities of the Met. Branch printing unit; co-ordinate with the Cdn. Govt. Printing Bureau for Met. Branch printing requirements beyond the capability of the Met. Branch printing unit.
7. Prepare lithographic specifications for maps, charts, graphs, diagrams and forms, compile, compute and draft maps, charts, graphs, diagrams and forms; advise section heads on design and layout of projects and investigate special drafting methods and equipment.
8. Prepare requisitions for printing requirements for all printing within the Branch; schedule printing jobs and investigate new methods of economical reproduction.
9. Arrange for procurement and repair of office machines and equipment and maintain inventories thereof.
10. Arrange for procurement and repair of furniture within budgetary allotments, certification of invoices and maintaining inventories thereof.
11. Co-ordinate arrangements for the repair and installation of telephones and inter-communication systems.
12. Manage and maintain property and services at the Scarborough Field Station and Meteorological Research and Development Site.

STORES

1. Requisition, receipt, storage, security, issue, shipment accounting and inventory of equipment, instruments and other Stores materials and supplies for issue to meteorological establishments throughout Canada, to ocean weather stations, to certain R.C.A.F. meteorological establishments outside Canada, and for Civil Aviation and Telecommunications stations in the Toronto Air Services Region.
2. Responsibilities similar to the above with regard to printing, stationery and office equipment items for meteorological establishments, ocean weather stations and, as required, for certain R.C.A.F. meteorological establishments outside Canada.

LIBRARY

1. Classification, cataloguing and filing of all acquisitions (books, periodicals, pamphlets, photographs, maps, etc.) and arranging for circulation and loan.
2. Administration of library service for branch offices.
3. Co-ordination of requirements for additions to the library and initiating recommendations in this connection where appropriate.
4. Providing an information service on availability of books, periodicals, pamphlets and other library material.

FEB - 1968

First Session—Twenty-eighth Parliament
1968

THE SENATE OF CANADA

PROCEEDINGS OF THE SPECIAL COMMITTEE ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 19

WEDNESDAY, DECEMBER 18th, 1968

WITNESSES:

Canadian National Railways: Maurice Archer, Vice-President, Research and Development; and Robert Rennie, Chief of Technical Research.

APPENDIX:

20.—Brief submitted by the Canadian National Railways.

THE QUEEN'S PRINTER, OTTAWA, 1969

29617—1

MEMBERS OF THE SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird	Hays	O'Leary (*Carleton*)
Belisle	Kinnear	Phillips (*Prince*)
Bourget	Lamontagne	Robichaud
Cameron	Lang	Sullivan
Desruisseaux	Leonard	Thompson
Grosart	MacKenzie	Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

29617—1½

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

WEDNESDAY, December 18th, 1968.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 3.30 p.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Aird, Belisle, Bourget, Cameron, Grosart, Hays, Kinnear and Robichaud. (9)

In attendance: Philip Pocock, Director of Research (Physical Science).

The following witnesses were heard:

CANADIAN NATIONAL RAILWAYS:

Maurice Archer, Vice-President, Research and Development; and
Robert Rennie, Chief of Technical Research.

(*A curriculum vitae of each witness follows these Minutes.*)

The following is printed as Appendix No. 20: Brief submitted by the Canadian National Railways.

At 5.30 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Archer, Maurice G.: Vice-President, Research & Development, C.N.R.; Born: Quebec City, October 4, 1910. Educated: Académie Commerciale de Québec; Royal Military College, Kingston; McGill University (C.E.) Consulting Engineer, Archer & Dufresne, Quebec, 1938-40; Vice-Chairman, National Harbours Board, Ottawa, 1952; Chairman, 1958; resigned 1961 to become Executive Assistant to President of E.G.M. Cape & Co. Ltd., Montreal. Joined CNR in 1963 as Vice-President, Research and Development, Montreal. Director: Jean Talon Hospital; Institut de Cardiologie, Montreal; Royal Canadian Geographical Society. Active service in army, 1940-45; served with 4 Med. Regt. RCA as Major and Lieutenant-Colonel, 1941-45; overseas service in Northwest Europe; Battery Commander, 2 i/c and commanded regiment for three months. Reserve Army, Brigadier CRA 4 Div. (R); Decorations: M.B.E., E.D. Member of Corporation of Professional Engineers, Province of Quebec; Engineering Institute of Canada.

Rennie, Robert P.: Age 50. B.Sc. (Honours) University of Manitoba 1939. M.Sc. University of Manitoba 1940. Inspecting Officer (Explosives) Inspection Board of the United Kingdom and Canada 1941-1945. Joined Canadian National Railways, Department of Research and Development in 1945 and has served in various positions in the research group in physical sciences. Presently Chief of Technical Research, Canadian National Railways.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Wednesday, December 18, 1968.

The Special Committee on Science Policy met this day at 3.30 p.m.

Senator Maurice Lamontagne (*Chairman*) in the Chair.

The Chairman: Honourable Senators: we have with us this afternoon the representatives of the Canadian National Railways. More specifically, Monsieur Maurice Archer, Vice President in charge of research and development, and Mr. Robert Rennie, Chief of Technical Research attached, of course, to the CNR.

Mr. Archer will make a brief opening statement and then we will proceed immediately afterwards to the discussion period.

Mr. Maurice Archer, Vice President, Research and Development, Canadian National Railways: Honourable senators, it is a pleasure for Mr. Rennie and me to be here with you today. We hope that we will be able to help your Committee in its work. We will do our best to answer all the questions you will ask us.

We have submitted a very short brief, attempting to indicate the role that the railways have played in this country, that the railway is still a growing industry, very much so, that Canadian National Railways is not uniquely a railroad company, but a transportation company and that because of the importance of transportation to this country some emphasis has got to be directed towards the education and training of personnel to fill the ranks of the transportation industry, as well as research in the transportation industry.

We have made three recommendations: one, the formation of a national transportation research council; another one, of a soils dynamics organization to coordinate the work of soils mechanics and dynamics being done in Canada; the third one is a transportation data bank for the flow of information where you can gather all the information and avoid duplication by knowing what the others are doing.

I think this completes my opening remarks, Mr. Chairman.

The Chairman: With this very brief opening statement we will be able to have a long and fruitful discussion period. Senator Bourget?

Senator Bourget: My first question will be to ask you, Mr. Archer, if you could give us for the benefit of the members who certainly have read the brief and also the appendix, but nevertheless, so as to have a general outlook of your organization, could you briefly summarize your set-up, particularly as far as its physical organization is concerned, its research staff, supporting staff, its administration and also the expenditures of the last three years and the next three or four years to come, so that we could have a good picture of the organization?

The Chairman: I am sure that you will not complain that this question is too specific.

Mr. Archer: I will answer as briefly as possible on this: I think it might serve a good purpose if I were to go back and tell you about the evolution of research and development in Canadian National Railways.

When the Canadian National Railways was created in 1923, shortly thereafter there was a Bureau of Economics set up, composed of 12 people. After about 15 years they added to the Bureau of Economics the National Resources Development section and then in 1945, after the war, there was a building near our shop in Montreal which was converted to a laboratory for technical research.

In the years between 1950 and 1960, I think around 1956, we introduced the Development Planning Branch as well as the Operations Research Branch as part of the Research and

Development Organization of the company. In 1965 we built a new lab just on the outskirts of Montreal, in Ville St. Laurent.

The new lab is a building of about 45,000 square feet for the administration personnel as well as for the technical and research people. We also have what we call a test track with a hump that permits us to bring cars from our yard and test various pieces of equipment as well as loading of commodities in them to avoid loss and damage and study the best methods of loading.

Then we have another building where we can bring a locomotive and cars in and do research on them or experiment on them.

R and D's total staff in Montreal is composed of 300 people, roughly, but only 150 here are of interest, I would think, to this Committee. The others are, for instance, real estate and industrial development, who report to the president through the R and D vice president.

There are three main branches I would think which employ approximately 150 people which are of interest to you. They are the Technical Research Branch, headed by a chief, Mr. Rennie here; the Development planning Branch, which has the costing research and costing section in it, and engineering economics in it; ad there is the Operationals Research Branch. Of the 150 people in it approximately 98 are in the Technical Research, 19 Operationals Research and about 30 in the Development Planning. Of these, about 5 per cent are PhD's; 25 per cent are Masters; and 70 per cent are Bachelors of Science or Business Administration.

The Chairman: Do you have the same figures by discipline?

Mr. Archer: We have it by discipline; yes, I have it broken down here, sir; in the Technical Research we have 5 per cent PhD's.

The Chairman: By discipline, engineers and so on?

Mr. Robert Rennie, Chief of Technical Research, Canadian National Railways: I do not think we have it by discipline, sir.

The Chairman: As between engineers and economists, and so on?

Mr. Archer: In the Technical Research they are mainly engineers, chemists, metallurgists, electronic engineers, electrical engineers. In the Operations Research Branch we have statisticians, economists, economotrists, or at least we are going to have one shortly, business administration people and graduates in operation research courses such as given at the University of Toronto.

In the Development Branch we have some engineers; many of these engineers have gone on to take an MBA course, so they are mainly economists in the Development Branch with MBA's and some engineers.

Does that answer your question?

The Chairman: Perhaps you could send us the exact figures, possibly, later on?

Mr. Rennie: Certainly.

Mr. Archer: As far as the total expenditures from these branches, approximately in the last three years I think the average was \$1.2 million; in 1965 it was \$1.1 million; in 1966, \$1.2 million; and in 1967, \$1.3 million.

The Chairman: This is the total?

Mr. Archer: The total for these three branches.

The Chairman: The total R and D for the CNR?

Mr. Archer: No, the total R and D for CNR is about double that, because R and D includes the library, industrial development, real estate, which are really not doing research, but using the research section.

The Chairman: That is what I mean; research and development in the accepted sense.

Mr. Archer: That is what I would say; this is the accepted sense here, but I would not put real estate as an R and D function.

The Chairman: No, that is what I mean; \$1.3 million is the total amount of money which CNR devotes to research and development work; that is it?

Senator Bourget: The \$1.3 million is for what year?

Mr. Rennie: This \$1.3 million sum is for 1967, and if I may add a comment here, we are anticipating that these will increase at the rate of about 6 per cent per year for the next three years.

Senator Bourget: Are you through, Mr. Archer, or have you got something else to add to the broad question I have asked you?

Mr. Archer: No.

Senator Bourget: Now regarding the amount of money you are spending, last year $1.3 million, does this money come from the CNR, or does it include grants that you may get from other organizations, the NRC, for instance?

Mr. Archer: It is mainly, I would say, from the CNR; we do get one grant that we have got in the last two years from the Department of Industry; we qualify under their program.

I believe the first year was around $50,000, I do not think these figures are confidential, and the last year was $100,000. The remainder is from resources within the company.

Senator Bourget: And does it include also if you have contracts that you are giving to some other scientific or research organization, and also the grants or the help that you may give to students?

Mr. Archer: That includes our total budget.

Senator Bourget: That is your total budget?

Mr. Archer: Yes; if we support some research outside, that is included in this budget. For instance, we are supporting some research on the solids pipeline with the Alberta Research Council and for that we pay a contribution of so much; that is included within this amount of $1.3 million, or these figures I have just given to you.

Senator Bourget: Now, is there any link or liaison with the newly formed research division of the Canadian Transport Commission? Did you have any occasion to discuss with them and to find out what kind of cooperation could exist between your research branch and their newly formed research branch?

Mr. Archer: I would say that Mr. Cope, who is heading the branch, has worked for Canadian National Railways he is a former employee of the Research Department of Canadian National Railways. I would think he is fairly familiar with our programs of research. We have had informal contacts with him personally in my department, where we are always in touch with him.

It is my intention to meet Mr. Cope shortly in the new year. I see he is forming a new branch. I think it is exceedingly important to ensure that there is proper coordination between the work they are going to do and what we are doing, to avoid duplication.

For instance, I know that Mr. Cope addressed a speech, I think at the end of October, to the Transportation Research Forum, if I remember well, where he was looking into the aero-train and having it studied, or perhaps to have it studied by the National Research Council.

We know he is doing that; we gather as much information as we can from him. We have been sitting in some of these meetings about the aero-train and the National Research Council, but I feel this is not sufficient, that we have to meet them and sit down with them and see what their programs are. I think they are just setting up their new research division.

I am not sure if they have all their plans laid out yet, so I am waiting for that, but I think I must emphasize that because of the limited amount of the research dollar we should ensure that there is no duplication of our work.

Senator Bourget: That is very good. Now, Mr. Archer, in reading your brief I noticed that your research activities were mainly in the economic field until 1945, after the war, and probably mainly in the economic field until 1964 also, but since you have that new research lab in Montreal has your activity changed in different disciplines of your research?

Mr. Archer: I would say that our activities changed; I was not there at the time though when we renovated this building for the first lab. With the new lab and expanding facilities we have added some very sophisticated equipment and possibly Mr. Rennie, who is in charge of the lab there and has been buying some of these instruments, might like to add something to this and talk to you a bit about the added activities.

Mr. Rennie: Since 1964 we have made a continuous effort to increase the depth and scope of our research activities. This has involved two phases: one is the acquisition of modern instrumentation, such as computers for data processing, advanced emission spectrographic equipment of all types, electron-microprobe equipment for advanced metallurgical studies.

Coincident with this program we followed a policy of trying to strengthen our professional staff by reinforcing our personnel as we are able with people with advanced training. I think this has probably had three major advantages for us: it has increased, as I said earlier, the scope and quality and depth of our research; it has increased the productivity of our research per dollar spent; and it has

offered, I think, a greater challenge to research with our staff and made our research effort attractive to obtaining first class people from the universities that we engage.

These I think have been the major changes since 1964.

Mr. Archer: I think I would like to add what I said at the beginning, that we have an impact track that is extremely important in the railway business because of the dynamics of railways. We did not have that before and we are developing certain models about the equipment, mathematical models, by which we will be able to predict the effect on equipment. If we want to put in a certain type of equipment we can check it with the computer before we build it.

Also, if we want to check what we call under-cushion devices, that is sliding devices in cars which reduce the impact, there are a number in manufacture and we have to check those, because we did run into trouble with some of them and this has permitted us to do more work in this field.

Senator Bourget: You mention in your brief that you have participated in much useful work with other transportation organizations, federal agencies, universities and scientific institutions.

Could you tell us what kind of organization, what working arrangements you have had with them?

Mr. Archer: We have been working with industry to a limited extent, but we have developed, for instance, what was known as the covered aluminum hopper car; the aluminum industry supplied the aluminum; the manufacturer or builder of cars built the car for us; and we designed it for him and tested it for him.

We worked, for instance, with the Alberta Research Council on solids pipelines research; I might say that the Department of Industry is also making a contribution towards that research.

We are working very closely with the National Research Council; we have an arrangement with the National Research Council, what we call an Associate Railway Committee, composed of ourselves and other railways and some of the more fundamental or basic problems are studied by the National Research Council. In cases like that we have supplied, for instance, a diesel engine for testing crude oil when we were exploring the possibilities of using crude oil instead of diesel oil and what would be the effect on the diesel engine. They still have that engine in their lab.

So, generally speaking, sometimes we provide equipment and material which we have; other times we provide talent; and other times we provide grants to support the research.

Senator Bourget: Is an important part of your work in research done by National Research Council?

Mr. Archer: No, I would say what they are doing is very important, but most of our work is done by us.

I did not mention it initially, but the type of research that we do is what I would call applied research. I think it was defined; it is for day-to-day problems and it has, let us say, a commercial objective to improve our productivity, to improve our service, to improve our safety. We do not do much basic research, or fundamental, long term research.

The Chairman: Would what you are doing not be more closely associated with what we define as development work, rather than applied research?

Mr. Archer: Yes, it is development from a source of applied research. For instance, we developed an electronic scale; a weigh in motion scale that can weigh a car when it is in motion up to 15 miles an hour. The scale was 115 feet long, roughly, to take a full car and be on the scale long enough so that you can measure accurately the weight.

We felt this was applied research from previous research that we had done—basic research—and we went one step further—development. We have cut down the size of this scale to about 30 feet, because now we measure the front trucks and then we measure separately the rear trucks, so the cost of the scale has gone down by about 75 per cent.

So that is the sort of work we do.

Senator Bourget: Have you ever had occasion to patent some of the results of your research and, if so, have you derived any revenue from such patent?

Mr. Archer: Every piece of research that we do that we can patent we patent it to protect ourselves.

Not all these patents, unfortunately for us, are marketable, but we have had a number of patents that have been marketable, five or six in the last two or three years.

Usually when we want to market these we call for proposals, or invite companies we know are interested in selling these products. We generally ask for a cash sum when we license the manufacturing of that particular product, and then a royalty on every unit sold afterwards.

We have derived, in answer directly to your question, some revenue from that and we hope to derive more, because we have got a few things coming up which are serving the railway and could serve other people too worldwide, I think.

Senator Bourget: Of course you could not tell us the amount; that is confidential. I would not ask that question.

Senator Grosart: Could I ask you what were the four patents for which you issued licences last year?

Mr. Archer: One was the electronic scale; one was a speedometer, a very accurate analogue speedometer for diesel locomotives; one was a temperature control instrument for diesel locomotives; another one was an electronic measuring instrument. If you wanted to measure the cube of a parcel, because now as you know our express and freight is working on weight and measurements, so to save a man multiplying he just takes this instrument and measures the three dimensions and he gets the answer on this instrument and we hope that this instrument will be well marketable, but these are hopes just now; this is licensed to a company.

Senator Cameron: Is this the evolution of the slide rule?

Mr. Archer: I think it is the slide rule principle based on electronics.

Senator Grosart: Who are the licensees, roughly, in general?

Mr. Archer: One was Canada Iron, on the scale. The other one ...

Mr. Rennie: The speedometer was Vapour Canada Limited and the volume measuring device was CAC Industries Limited, in Montreal.

Senator Grosart: So they are going to manufacture them for general commercial distribution?

Mr. Archer: That is right, sir.

Senator Bourget: I have noticed in your brief, Mr. Archer, that one of your recommendations, and I think as far as I can see it is one of the most important recommendations, that it must interest all members of the Committee also, and it has to do with the formation of a national transportation research council.

So could you tell the members of the Committee how do you envisage the composition of that council? Should it be an independent body, or a government organization fully and completely financed by the government, or what have you?

The Chairman: Before we go into this, may I ask a kind of preliminary question? Perhaps you may not want to answer it, but because the CPR are not going to appear before us for a while, as they will only be part of our third phase when we will have the private sector before us, could you tell us in very general terms if the work they are doing in the field of R and D is more or less at the same level as the one you are doing?

Mr. Archer: Their organization of R and D as far as I have been able to establish is different than ours; it is not as concentrated under one department as ours is. I do not think they have as big a lab as we have; they have a number, I understand, of small labs for testing purposes.

They are not here, but they can read the remarks there; I think in technical research we are doing more than they are; that is my impression.

The Chairman: So it would be in the same area, more or less at the level of development work really, but they are doing probably less than you are doing?

Mr. Archer: That is my impression, although they do some good work.

Senator Bourget: They have not got the physical facilities that you have?

Mr. Archer: They have not got a lab like we have.

Senator Bourget: Coming back to my question, I suppose you understood it, Mr. Archer, how do you envisage the composition of that research council for transportation?

Mr. Archer: May I just with your permission tell you why we made this recommendation first: We have given some thought to it, that the transportation industry is vital to our

economy. I think you mentioned that in your opening remarks, certain statistics I think which were prepared by the Science Secretariat last year, or in the month of May of this year, showed that in the transportation industry there is 1.2 per cent university graduates, of the labour force, where in the total element in all the industries in Canada it is about 4.2 per cent, or slightly over 4 per cent.

There is a gap there and I think that gap has got to be filled, that we have got to train more talent, more young men to join the ranks of the transportation industry.

Also that research activity is closely related to the productivity or increases in productivity of any company.

I think you will also agree that with the accelerated pace of technology today there is a dependence between innovation and the growth of a company. Therefore it is essential that we make an assessment of what is being done in research in the transportation industry and what should be done.

I do not think I am the first one to say this; this has been said before, but we are more or less confirming or supporting others who have said this: there are many vehicles through which you could expand your training and education at university level as well as expand your research and coordinate your research to avoid duplication. We have recommended a council; we think this council, and this could be studied further, I am not saying this is conclusive, but this council should be composed of government representatives, university representatives and industry representatives.

How it should be financed? I think that certainly in the initial stages the government would have to provide some of the financing; I cannot speak for other industries, but I know that Canadian National Railways would make a contribution to membership in such a council.

Now, where should this council be attached? There are I suppose many possibilities; I would like to suggest possibly the National Research Council, or the CTC, the Canadian Transport Commission, but this council would have to be independent of politics and be able to act very freely, whether it came under a government department or a corporation.

The Chairman: Do you visualize this council as doing intra-mural research itself, or only serving as a granting body?

Mr. Archer: I would see this council making an assessment, a survey of the research that is being done in the transportation field, determining to the best of its ability what should be done and then ensuring that the research is properly distributed towards various bodies doing research, to avoid duplication. I would say that this council would award or recommend awards or grants for research to universities or to industry. I would see also this council taking an active part in ensuring that the ranks of the transportation industry are filled with the necessary talent for managing and for planning for the future of our transportation.

I do not know if that answers your question.

The Chairman: Only partly. I do not know if I am taking too much time of the Committee this afternoon, but I think it is an important phase of our inquiry.

We heard, for instance, this morning the representatives of the Department of Transport. Apart from the research which is being done there in the field of meteorology, the other research activities of the department are really in the field of development work, very, very applied, and very mission-oriented, and almost a day-to-day operation.

It seems to me that from your brief and from what you have told us this afternoon that in so far as the CNR is concerned it is more or less the same thing, and more so in the case of the CPR; so that we do not have at the moment in Canada any kind of centre which is doing research of a more fundamental or even of a higher level, applied activity, and therefore it seems to me that there is a gap there. I do not know if the Canadian Transport Commission is going to fill that gap, but there is certainly a gap here in so far as research is concerned, and in helping and encouraging universities in that field.

Mr. Archer: I would see, Mr. Chairman, various centres of research specializing in certain types of research. For instance, one university specializing in railway research, another one in highway research,—spread across the country. And from this council possibly you could give out and have a number of research institutes across Canada granting diplomas, university diplomas.

I want to make the point that my thinking is that these institutes should be affiliated to universities, so that they can give university degrees acceptable to the universities; also that the universities should do some research.

I can say that we have spoken to one university just recently about this. They said, "If we were to engage in this field would you encourage us, would you give us some research?" We replied that we certainly would.

The Chairman: But again would this kind of assistance to industry for doing more development work and greater assistance to universities in order to prepare more people, more experts in the field of transportation and even grants for research to university staff, would that be enough? Usually when government organizations start grants-in-aid programs to universities they merely receive applications for a grant, and the initiator of that application chooses his area of research. Then the application is either refused or accepted. But this kind of method, it seems to me, can leave very important gaps in the whole program of research, even if you give more assistance to universities to prepare more experts and to enable the staff to do more research.

Mr. Archer: Well, I would see universities not doing applied research, but doing more basic, fundamental, long range research. I do not think they would engage very much in applied research. We could do that part of it and the development part of it at least. I could see universities in a plan like this being given grants and awards in areas for fundamental and more basic research. What we are doing to some extent with the National Research Council when we have a fundamental problem, we bring it to the Council because we are not equipped to do it. For instance, we have fatigue problems; we would not think of doing research in fatigue work, we go to the National Research Council for it.

Senator Bourget: So do you think that a research council like this, which will cover the whole field of research in transportation and probably as usual be financed by the government, should be attached to either—I am giving two instances—the National Research Council or the new Canadian Transport Commission, or should it be completely independent?

Mr. Archer: That is a difficult question to give a very definitive to, because this is being studied now. I would see nothing wrong in that being attached to the Canadian Transport Commission.

Senator Bourget: Because what we want to avoid is duplication.

The Chairman: I am sure that this is the answer we will receive tomorrow afternoon.

Senator Bourget: You see, that is what we want to avoid, duplication and loss of efforts. We have seen this and we have been told it so often that it is always in our mind. So we like your recommendation, but we would like to have from you the way it will work, or your suggestion.

Mr. Archer: My answer to this is that I see nothing wrong to having it under the National Research Council or the CTC, the Canadian Transport Commission, but being able to act independently with people from outside, universities, industry and government.

Senator Grosart: But, Mr. Archer, surely this is exactly what the research side of the Canadian Transport Commission is. The act specifically requires the Canadian Transport Commission to support a research department under one of two vice presidents, and he is given exactly the terms of reference that you have indicated for this national transportation research council. Why another one?

Mr. Archer: I would certainly like to see universities have a word to say in this and industry having a word to say in this.

The Chairman: They have set up an advisory committee, I understand, composed of the representatives at least of the universities. We do not have the names of the members of that committee, but I am sure we will get them tomorrow.

Senator Grosart: Can you explain, Mr. Archer, why it appears that after all these years of Canada dealing with transportation problems of such tremendous importance to our economy there has never been a broad study of the transportation system of Canada as a whole? Why in 1968 are we talking about this starting now?

The Chairman: Do not put aside the series of royal commissions that were appointed.

Senator Grosart: There were royal commissions, but I was very careful in wording my statement, because those were the words of Dr. Solandt. No one as yet has done a study of the Canadian transportation system as a whole; again, no one has looked at it as a

whole, to see whether or not the pattern of emphasis in our research is related to our needs.

This is Dr. Solandt, who has had very close experience with the transportation problem. Will you tell me why in Canada in 1968 we are still talking about doing this?

Mr. Archer: I suppose everybody kept independently looking after their own needs and now they realize that by coordinating their work and avoiding duplication this is necessary for the development and expansion of the transportation industry.

Senator Grosart: I think you are really ducking my question. I am asking you why only now do they realize this?

Mr. Archer: I really cannot answer it; maybe it was thought of before, but it never got to first base.

Senator Cameron: If I might interrupt there, a question that might tie in there: What year did Dr. Solandt go in as vice president of research and development of the CNR? How long was he there?

Mr. Archer: About seven years, from 1955 to 1963.

Senator Cameron: You might say why did Dr. Solandt not do something about it.

Senator Grosart: I am not speaking for Dr. Solandt; he would have a very good answer. But this is not a function of the CNR specifically. It is somebody's function somewhere amongst the 20 million people we have. Surely somebody has had the responsibility before this of looking at the whole problem. As Dr. Solandt says, the royal commissions you mentioned were looking at really quite narrow, specific problems. That is his summary of all the royal commissions.

The Chairman: Not all royal commissions.

Senator Grosart: I am just saying this is Dr. Solandt's summary, Mr. Chairman; I am not saying it is my own.

The Chairman: You are not saying it is true, either.

Senator Grosart: He says: how can we improve it? I think one of the first things is to back off a little and ask: what are Canada's transportation problems, and, if we were starting over again, what kind of a system would we have? For instance, what balance should we have between roads, rail, pipelines and airlines?

This was evidence Dr. Solandt gave before this Committee on November 26.

The Chairman: I think it was as a result of a question of mine, if I remember well.

Senator Grosart: I will not dispute that.

Senator Bourget: Following the question of Senator Grosart, are you aware of the amount of research that has been made in transportation in the United States, except in the air field; in railroad, for instance?

Mr. Archer: Railroads in the United States have made a survey a few years ago; I do not have the figures, but on the whole they are not doing too much in railroads in the United States as an industry. They have an American Association of Railroads that has a lab and all the major railroad companies belong to that association. So do we, because of the international character of our traffic, but just recently we felt there was a need for this because the government of the United States have granted $90 million for research for high speed ground transportation.

I would say that Canadian National Railways in proportion to its gross revenue is doing about .1 per cent.

Mr. Rennie: Yes, if I may add something here: We did a survey of 72 per cent of the Class I American railroads and their R and D expenditures as percentage of gross revenue was 0.07 per cent as against .14 per cent for the Canadian National, just about half on a percentage basis.

Senator Grosart: But what percentage of the CNR research was on railroads? Otherwise, it is not a fair comparison. It would not be fair to take CN research on steamships, on air, on hotels, and so on, and contrast this with an American railroad which is only in the railroad business.

Mr. Archer: Generally speaking I would say, senator, that 80 per cent of our research is for railroads.

Senator Grosart: It is?

Mr. Archer: Yes; our technical lab is working mainly for the railroad, but there are other problems. For instance, ships, at times we have to do some research on them too, the hulls of ships, but most of our research is for the railroad operation.

The Chairman: Are you doing any research related to air transportation?

Mr. Archer: Not to air transportation, no.

Senator Bourget: Mr. Chairman, I have other questions, but I think I have taken about half of the time of this meeting.

Senator Robichaud: Mr. Chairman, I have three questions for Mr. Archer: We know that for years our railways have been using outmoded refrigeration equipment. Has any research been done in this field and could you give us a brief outline as to the progress that has been made in having modern refrigerator cars now which can keep food at a proper temperature and deliver it in the proper quality?

Mr. Archer: I will answer generally, then I will ask Mr. Rennie, who has done some specific research on this: We have a fleet of ice-actuated cars, refrigerated cars with ice. We are converting those to mechanical, but that involves still fairly large sums of money and we are not doing the whole fleet in one year; we are doing it gradually.

Senator Robichaud: What percentage has been converted?

Mr. Rennie: I would say at the moment about 50 per cent, sir.

Senator Robichaud: And you keep them at what temperature?

Mr. Rennie: These are of two types: there is one which is designed for 32 degrees for perishable products that must not be frozen, then there is a second car which is what we term a dual-purpose car, which will do that job and at the same time handle frozen products for trans-shipment.

Senator Robichaud: At what? Ten below?

Mr. Rennie: We try for ten below under all conditions of ambient temperatures in Canada and the United States.

Mr. Archer: I think you should expand on that.

Mr. Rennie: If I may, Mr. Chairman: In 1956 we had a very large fleet of refrigerator cars, some 3,800, of which some were of recent origin. We entered into a research program to convert them to mechanical refrigeration because of the economies involved. We designed a car which was a conversion to mechanical refrigeration; we have converted about 600 of these cars at the moment. Just about two years ago we entered into a research program to develop a new car employing modern material engineering with the newer types of insulation and so forth, and last year put on the road a prototype car which we feel at the moment is probably the best car in North America for this purpose. This car is under test, or has been under test for a year, and I believe that in the coming year substantial orders will be placed for this car, which will form the new car for the next few years to come.

Senator Robichaud: What about package refrigeration, say for express shipment; have you done much research in that field?

Mr. Rennie: We are now doing research on package shipments, for example for containers or for piggyback trailers. We have some in service with certain types of refrigeration.

We are undertaking research programs to improve, modify, simplify the types of units which are available.

Senator Grosart: To what extent have you participated in the very extensive research going on in containerization?

Mr. Archer: We do not do much technical research on it. Mainly because of the revolution in containers, we have set up a special branch in the railway, known as the Container Development Branch. Our two main concerns are the land-bridge and the domestic traffic. We are doing some slight industrial engineering research, if we may use that term, in methods of loading and unloading on to trucks from flat cars or loading to flat cars. We have designed some of our own containers, particularly in the Newfoundland service, and our particular research work has been mainly there with the refrigerated type of container.

Mainly our work now in this field is in market research and economic studies, to establish rates and hoping to get a lot of traffic out of it. We also have a contract with Manchester Lines to move containers from Montreal to domestic points in Canada, or to destinations in the United States.

Senator Grosart: Is research in this area inhibited by existing patents to any great extent?

Mr. Archer: We are not trying to design a container; the containers do not belong to us, except our own domestic ones. If they come

by ship they usually belong to the shipping company, I believe. So we are accepting those and we arrange our cars so that we can load those and they are seeking to standardize those.

We do not intend buying containers for inter-modal service, at least I do not think we do, just now. We would buy some which are made and manufactured by others.

Senator Grosart: If the system went back into the mercantile field in a substantial way, as it appears to have been recommended by some, then you might want to develop your own containers, because they would be the essential link between your rail and your ships; you have not contemplated that at the moment?

Mr. Archer: No. I would think we would do very much the same as we do when we buy cars. The manufacturers offer us a certain car; from our experience with that car, the next time we order them we modify our specifications to suit our needs. We find sometimes there are weaknesses in the car and we will correct those, do some research on them and we would do the same thing with containers.

Senator Bourget: This question of containers also relates very closely to the question of the land bridge which so many people are talking about and as a matter of fact it is reported in the report of the President of the National Research Council at page 32 of his 1967, 1968 report, and this is what he had to say:

> To meet this challenge...

The challenge of the land bridge.

> ...however, we had two very efficient railroads to choose from from coast to coast. Moreover it is reported that Canada can provide more efficient port handling facilities than one has seen to date on this continent or in Europe. However, an all out effort needs to be made if Canada is to develop the container technique to full advantage for domestic use and as a Canadian land bridge. The division of mechanical engineering is undertaking programs to improve railways, containers and ports to help meet one of the strongest challenges that this country has ever been called upon to face....

I was reading from an article which appeared in the *New York Times*. This kind of business relating to the land bridge means multibillion dollars of business, so has the CNR been interested in that project?

Mr. Archer: As I just mentioned I think earlier, we have formed a special division on containers. We published a book on it, which I happen to have. I sort of expected a question on containers.

We also have "The CN Prepares For Container Revolution". This is directed by a vice president who devotes all of his time to the container business. We have been over to Europe studying the container, seeing how we could work with the land bridge, that is from Europe across to Japan or from Japan or the Far East across. We have a contract with Manchester Lines; the first ship arrived about a month ago in Montreal. We handled about 160 containers.

We have inland facilities for change from rail to road or from road to rail and for delivery of these containers door-to-door. We also have repair facilities, and facilities to store the containers, if necessary, or if required, and hold them until they are called for for return shipment.

The Chairman: Is there any kind of co-ordination of effort in this field at the moment, because the CNR or the railways cannot provide all the answers nor the preparations for this revolution? We need new harbour facilities, and perhaps we will need new ships, and so on. Is there any other federal agency involved in this?

Mr. Archer: I would say that possibly the National Harbours Board is involved and I understand that they are going to put up a crane on one of the piers, centennial pier in Vancouver, and in Halifax I believe it is the Port Commission who are very active in this. We are working very closely with them on this. There is a pier now being built for container movements.

The Chairman: In Halifax?

Mr. Archer: In Halifax. And I am not sure of this, but we have had meetings with these people; I am sure they want to put up a container crane there and that is a very heavy crane to handle containers; in the meantime until that is built we can unload these containers with the ordinary moving crane.

The Chairman: But would it not be more economic to use some of the St. Lawrence ports?

Mr. Archer: That is the shipping companies who decide where to go and there is the question of rates. For instance, Manchester Lines decided to build three container ships and they made agreements to rent a pier in Montreal to dock these ships and to be able to handle them very quickly, because that is what you have got to be able to do.

There are other shipping companies and I think it appeared in the press recently that Clark Steamship with other companies are now looking into the possibilities of building container ships and bringing them into either Montreal, Quebec or Halifax.

This is a competitive field between shipping companies; it is a competitive field too between the railways.

The Chairman: But is there much competition in this new field that can come from the United States, for instance?

Senator Bourget: Sure.

Mr. Archer: I think that like any competition we can offer competition to them, because I think we can deliver containers from Montreal and from other ports into the States, but it is a very competitive field, the same as any other cargo, as a matter of fact.

Senator Bourget: As mentioned by the President of the National Research Council, the big challenge is are we going to win in the competition that now exists on that land bridge between the United States and Canada? I think we have certain advantages and I suppose that CNR or CPR, I do not know which one of the two, is going to take that trade, but I suppose they are well organized and they have done research so as to be in a position to compete on that particular market, which means millions and millions of dollars. It was stressed by the President of the National Research Council that it is the greatest challenge that the railroads are facing today, because they will be in operation maybe let us say in 1970, if not earlier.

Mr. Archer: I think we have the first step of the land bridge through Montreal, through Halifax as it is going, and now through Vancouver.

Now, it is going to be a competitive field; we have this new division who do nothing but study containers, the market for containers. We hope to win the battle.

The Chairman: It would be the first time in our history that we win against the Americans, except in the war of 1812.

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Senator Grosart: They have invaded us twice and never won a foot of land.

The Chairman: No; I mean in terms of transportation.

Senator Cameron: The transportation industry represents I believe about 7 per cent of the GNP, which gives a perspective of its total importance and it would certainly seem worth while spending a lot of money on this aspect of it.

There was another statement I read, which was a surprise to me; I did not realize that it had gone to this extent. That was that 70 per cent of the energy fuels are now transported by pipelines; this includes coal, oil and other things. Is this a fact, or is it a figure somebody has pulled out of the hat? I did not think it was that large.

Mr. Archer: Much hydrocarbons now are carried by pipelines; there are not any major solids pipelines for coal in Canada.

Senator Cameron: There is one in the States.

Mr. Archer: But I think, sir, it was put out of action by a unit train, or an integral train. They built the line then they instituted an integral train and this train has taken over the business now and the pipeline is inoperative.

There is another solids pipeline in the States, 72 miles long. As I say, it is certainly a field we have got to be very active in and we are participating in research in this and it could be that solids will be moved by pipelines in large quantities, bulk commodities, it could be sulphur, it could be potash.

Senator Cameron: There was a bill came into the Senate two years ago to build a sulphur pipeline from Pincher Creek to Chicago; it has not got off the ground yet, but it was physically possibly. This was the Pembina pipelines people doing it. There is also transportation of propanes and all the other extracts and these are coming. I know a little about the solids pipeline because I have been on the Faculty of the University of Alberta for a long time so I know that work. This figure struck me as being rather high, but it is certainly an indication, whether it is high or low, that here is an area that also is entering into this total picture which we must be conversant with.

The Chairman: Are you involved in research on pipelines?

Mr. Archer: We are not doing research ourselves. There are about ten companies who contribute to that with the government, and they—Alberta Research Council—are in the first stage of this research program to establish the economics of it, and the feasibility of the transportation of materials. The second phase will be the technical phase; what physical things do we have to overcome yet? I mean, pumps, the size of pipe, etc. This is a capsule pipeline, as you know. There is research going on as far as pipelines in the States, particularly in sulphur. I think it could be very active field, solids pipelines, and Canadian National Railways are certainly looking into it.

I cannot disclose anything here, but we are discussing with certain people the prospects of moving sulphur, because sulphur is moving in such vast quantities now from the west. As a matter of fact, we are building a branch line not far from Edmonton at present to service the sulphur industry.

Senator Bourget: Have you ever carried out research into going into the business of transportation by pipeline also?

Mr. Archer: Certainly the CNR would go into the solids pipeline as a matter of policy; it would have to be decided by our board, but I can tell you my feeling, we would not pay for the research otherwise and if it starts moving by pipeline we want to get into that business. Mind you, there are means of competition to this; the unit train is a very strong one and has defeated the pipeline.

The Chairman: Perhaps that is only temporary.

Senator Cameron: Is it true that some work has been done on transferring wheat by pipeline?

Mr. Archer: The only work that I would know, sir, would be the capsule pipelines they are looking at; maybe you could move wheat by capsule this way.

Senator Cameron: Move it in oil?

Mr. Archer: Yes, in a capsule using oil, the same as sulphur, as the fluid; so you would get two commodities moving at the same time.

Senator Cameron: There is nothing other than that experiment going on now?

Mr. Archer: This is based on experiments we have done ourselves; we participated in wood chip pipelines with the Pulp and Paper Association in Montreal. We have been very active in that, but there has been no pipeline built in this field yet.

Senator Bourget: Has CNR carried out research in inter-city rapid transit, or into high speed ground transportation, and if so what is your interest in that area?

This is a very important problem I think.

Mr. Archer: We do not do research directly; I mean, such as the aero-train or the linear motor. We do not do it directly but we are keeping an eye on what is going on.

As you know, we have just started the Turbo Train to Toronto, which cuts down the time by one hour.

The Chairman: Not on the first trip.

Mr. Archer: In the other direction; I think as someone said, it proves that the train can take quite a beating.

Senator Cameron: I thought Senator Bourget was going to ask you why it took CNR so long to get into this field?

Mr. Archer: Am I supposed to answer that question?

Senator Bourget: No, but it is a very important problem. The CNR has set up a kind of subcommittee between the cities and the CNR and all the other authorities concerned to solve that problem, because it is becoming more and more an important problem, not only regarding transportation, but also the urban problems that are involved in that particular area.

Mr. Archer: The closest we have come to this and done something is with the Government of Ontario, as you know, the GO System, which operates from Hamilton to Pickering, about 40 miles. That is an arrangement where the Government of Ontario has bought the cars; we rent our track; they use them and we supply the crews on the trains.

Senator Grosart: Is there not an implied criticism of the railroads, that the Government of Ontario had to initiate this?

Mr. Archer: There is a big matter of policy I would rather see our president discuss, but we are not in the commuter business.

Senator Grosart: Why are you not?

Mr. Archer: Well, this is another matter. We have not been in the commuter business; we have been in long-distance travel. We have not got the type of trains for it. I suppose that is why we are not in it. I think the only commuter service we provide is in Montreal, and this service has been in existence for a number of years. But I do not think I would like to discuss that too much here, sir, because I do not know all the background. These are matters of major policy. We have never been in it, but we are prepared to cooperate with people.

Senator Cameron: Someone is going to have to answer questions as to why they are not in it, because it is just a scandal today when you try to get out to an airport. Take Malton, for example, at this time of night, from about 4.30 on, to get out there it takes at least an hour and a half, if you are lucky, on a bad night. Last Thursday it took me two hours to get from the east side terminal in New York to Kennedy International Airport, the most frustrating, worst buffeting I have ever had, meeting stoplights all the way through. This is just nonsense in this age. Whether it is the railways' responsibility or the cities', somebody has got to do something and they had better do it fast. The Go Train is a move in that direction, whoever initiated it, but it is only a beginning.

Mr. Archer: I must say that we did study for someone a few years ago transportation between Montreal and Dorval. We found that the best kind of transportation is still by highway, now through Decarie Boulevard. It is the fastest.

When you have to provide the service practically 24 hours a day, which is fairly expensive, this is the best means of providing it economically; I think it is all a matter of economics.

You could put some trains in there and spend millions of dollars without any return on it, sir. We have found that there are a number of passengers who use the limousine service, and there are quite a few who use private cars. So just now our feeling is that for Montreal the fastest means, the best means is still the limousine service, because they have got good boulevards.

I agree with you. What you have said. I travel by plane. Although I am with the railway I use the plane now and then, and it is frustrating. I am not too sure if the CTC are not looking into this. We have been approached, and possibly other railways too, to have a look at the problem and try to come up with an answer as to how to bring passengers into the downtown area of a city in twenty minutes or so after they have crossed the ocean in a supersonic jet in two hours. The first thing we would have to know is where the airport is to be located, and I do not think this has been decided.

Senator Cameron: When you say you travel by air, you and Mr. Crump must be in league, because he is trying to get rid of the passenger train. I happened to be in Banff the day the first train of the *Canadian* went through. and everybody was proud of it. Six years later I stood on the same platform and Mr. Crump said "There is the most rapidly obsolescing piece of railway equipment ever made." He said that it was finished. That was his idea seven or eight years ago.

Mr. Archer: I would like to say something about the passenger business, Canadian National is very active in this in the intercity, with the Turbo Train and that sort of thing. We have been spending a lot of time on it.

Senator Cameron: We give you full credit.

Senator Grosart: Mr. Archer, we seem to be discussing some tremendous areas of needed research in the transportation field, and many of them would seem to be germane to the interests of the CNR. Are you satisfied that $1.3 million is enough for the CNR to spend on research?

Mr. Archer: We have a budget every year and I think, seeing as we are not doing fundamental research, which other people can do, that we are doing the job we are asked to do, to solve the day-to-day problems, to correct existing problems. We have to assign priorities to our problems sometimes, but I think it is good in a budget that you do not have too much money all the time, that you have to assign these priorities and determine them. We are very happy to be able to work with the National Research Council on these fundamental research problems, which is money spent in addition to what we are doing.

There is also some work done with the AAR. We are looking very closely at what the United States are doing in the fast passenger field. As a matter of fact we have been asked to do certain tests for them. We have certain pieces of equipment to measure ride characteristics, which for instance we are doing for them.

The Chairman: This is probably why in answer to Senator Grosart's question you want to have this new institute. It seems to me that as we go into this new technological revolution in transport that research in the field of transport will have to become more and more inter-modal.

Mr. Archer: Integrated?

The Chairman: Integrated as to the various means of transportation. Each sector of transportation will have to find its own new vocation so that we have really efficient applied research to move away in a certain way from specific means of transportation and have an overall research program.

Senator Bourget: Exactly.

Senator Grosart: But the revolution, Mr. Chairman, is not that new, because we have had the automobile for 50 or 60 years, the airplane for 40. We are talking about a new technological revolution in transport. There is nothing new about it. This has gradually built up, and the evidence here is that nobody in Canada has done anything about it. It is amazing.

Also, we had some evidence this morning about the lack of development of any centre of excellence in transportation research in Canadian universities. It surprises me that the CNR and the CPR, with their headquarters in Montreal, has not made some attempt to set up a centre of excellence in a Montreal university. It seems to me that in your answers to some of the guideline questions here you are not very much interested in grants or contracts to universities to help you in this field.

Has there been a reason for this policy? For example, on page 3, expenditures associated with scientific activity: all expenditures associated with scientific activities are on one intra-mural R and D and (4), that is a reference to one of the questions, testing and standardization.

All your research is intra-mural; is that right?

Mr. Archer: Most of it is, except for the National Research Council and sometimes with the industry. To what extent are those in the universities prepared to do some railway research? I am not sure. I said that recently we were approached by one university and they asked us if we would support them if they were to do something specialized in the field of railway research and we said we would.

The Chairman: But, generally speaking, was the assumption that this responsibility for developing and maintaining an interest in research at the university level more or less a responsibility of the Department of Transport, rather than CNR? Was this the assumption which was made, or was it just a lack of interest from the CNR?

Mr. Archer: I must say that a few years ago, and I will not mention the university, we had one fundamental problem and we wanted to give a small grant. We discussed it with the Dean of the Faculty of Science and he never came back to us. We had given him three problems and asked him to pick any one of them, that we would like them studied. They were long-range and we said we would give them a grant of so much per year to work with their students. As a matter of fact, I went back to him once and saw him. I asked him what he was doing about it. He said, "I will speak to our Dean of that faculty". That was a year ago.

The Chairman: They were more interested in pure physics, I suppose.

Mr. Archer: I presume they were, but it may be on the part of the university too. I would say, too, that there is much research done by industry; for instance, in diesel locomotives there is a tremendous research lab.

The Chairman: Yes. While I am quite interested in diesel locomotives, it seems to me that they might be pretty soon obsolete too. While this is useful work for you, perhaps universities or other research centres should be more interested in developing new ideas which might be applied later.

Mr. Archer: We agree with you. That is why we are recommending a council to make a survey of what is being done and what should be done.

Senator Grosart: The anomaly there is that it was an automobile manufacturer who developed the diesel engine for the railroad.

Senator Kinnear: Also, Mr. Chairman, it seems to me that the universities could supply talent much more quickly if they changed some of their disciplines. If they changed the engineering disciplines, the varied disciplines there and included the MBA.

Nearly all engineers are having to go back for two years for their MBA and it is the first question I ask: Have you your MBA of an engineer? No, No; well, he just waits until the time when he can get back.

If that could be applied in all these research problems, then we would receive much better talent from the universities.

The Chairman: Is that not true that, for instance, in Canada we have to rely heavily in the field of research on people coming from other countries?

Mr. Archer: That is not true in our case with our applied research and development; we do all our recruiting in our universities.

We have a few outsiders too, but they are new Canadians; they are very intelligent, but all our recruitment is done at our universities here. We encourage in some instances further studies.

I think I would like to make a point clear: I am not saying that there is not enough research done in the transportation industry; I am not trying to make a case of this, that there is going to be more.

Senator Kinnear: I am discouraged to have the passenger service discounted, that you are not doing more study in that, the one that Senator Bourget asked about, the rapid transit and the intercity communication.

People in heavily populated areas have to go 90 miles to get to an airport. Just take Niagara Falls; we all go 90 miles to get to Malton. You have a day-liner that runs from Niagara Falls about twice a day, but on the shore of Lake Erie there is nothing; the CNR is not in there at all. There is no CNR service until you get to Niagara Falls, St. Catharines and Hamilton on the Lake Ontario shore.

It is a great inconvenience; sometimes I spend a day getting down here. It just seems I could almost walk it. Busy people give a great deal of time to try to get here.

Mr. Archer: I think if we were to do very fundamental research, such as they are doing in the United States, on high speed ground transportation, it has not been by the railway; the government has given $90 million for that. The aero-train, I am quite sure, in France, is being developed with very large support from the French government. These demand fantastic sums to develop; just the budget in the United States is $90 million in three years.

Senator Bourget: And just in this one area; that $90 million has been given by the Commerce Department to MIT to carry out some research on ground speed transportation, just one sphere of activity of railways. Imagine the sum of money that the United States government spends.

So I suppose the final answer would be we have not got enough money to do it. Would that be it?

Mr. Archer: We have not got money to develop the aero-train, for instance, but we have the money to look at our lines and see how we can increase the speeds on them, as we have done with the turbo at CTC—Centralized Traffic Control—and at various other physical features to make it possible to go at these speeds.

Senator Kinnear: Or have more connecting bus lines or something that will bet you to an airport so that you are able to use your own car, leaving it there two or three weeks at a time, and then travel back through fog. That is the point.

Senator Robichaud: Has not the volume of passenger traffic something to do with this too? We talk about certain improvements of certain types of facilities in countries where there is a heavy density of population. Has the size of our country and the volume of population something to do with such matters?

Mr. Archer: We have a large passenger deficit in Canadian National Railways. The characteristics of these fast trains mean that you must have large centres within 200 to 400 miles. There are trains such as those on the new Tokaido line. I have ridden 325 miles in Japan on trains going at 130 miles an hour. They built a new line costing $1 billion and have about 180,000 passengers a day. They have a population of 45 million in just that little corridor. I think that has something to do with the economics of it too.

Senator Grosart: They are losing money.

Mr. Archer: If there is a new turbo or aero-train we can buy it; we do not have to develop it ourselves. The turbo was not developed by Canadian National Railways; the new principles in that were developed by an outside company; we looked at them and gave them the specifications we wanted for a train.

Senator Bourget: What about the new modes of transportation such as the air-cushion train, monorail or vacuum tunnel? Is there any chance of your making some research into that, or do you rely mostly on the studies and research being made in other countries such as England, Japan or the States? I understand you have just come back from Japan.

Mr. Archer: Yes, sir. For instance, only last week we had with us the people who are building the aero-train in France and we discussed it with them. This matter is also being reviewed by the Canadian Transport Commission to see whether this train is applicable to our climate. If we tried to develop that train we would have to spend millions of dollars, and we are not sure of success. I think we rely on faster passenger trains being developed by others, and the turbo is an example.

Senator Bourget: As a matter of fact, is not the turbo train the fastest in North America today?

Mr. Archer: Yes, it is the fastest in North America.

Senator Bourget: Who developed that, or helped to develop it?

Mr. Archer: United Aircraft. It is their conception of applying aeronautical techniques to railway problems, with different suspension and so on.

Senator Bourget: You have just returned from Japan and I think it would be interesting to hear from you what kind of research organization they have there. Are they more advanced than we are in Canada? Who supplies the money? Is it done through government-owned research laboratories, or whatever you call it?

Mr. Archer: The Japanese National Railways is owned by the state of Japan. It has huge deficits, although I do not know the sums. They have fairly large research facilities. They do more fundamental research than we do. On fatigue work they do the research themselves. If we had any fatigue problems ourselves we would go to the National Research Council. They conduct larger research. That also seems to apply somewhat to some of the European countries. They do all their design work and everything for their locomotives, cars and everything else. Whereas much of our design work is done by manufacturers on, for instance, as I was saying, diesels or new cars, they will do their own designs themselves. We do some of our design by taking some designs, correcting them and adapting them to our own problems.

Senator Bourget: Are you aware of what kind of organization they have? Are they autonomous? Is there a central organization in Japan that looks after transportation research?

Mr. Rennie: I can answer that. They completely look after their own research within their own railway organization. They have their own special railway transportation group for doing that.

The Chairman: It is limited to the railways?

Mr. Rennie: It is limited to the railways.

Senator Robichaud: Is it not also a fact that they may have more finance and patience than we would have? I was a passenger aboard one of those fast trains. They had a six-month trial run over a distance of about 250 miles and ran empty trains for the six months, on one road only.

Mr. Archer: I think it took them approximately seven years to build this new line and build this train and the figure has reached over $1 billion for a line which would be equivalent to Montreal-Toronto.

Senator Bourget: How much?

Mr. Rennie: A billion dollars.

Senator Cameron: This is the Osaka-Tokyo Express?

Mr. Rennie: Yes.

Senator Cameron: They have done a magnificent job for you, of course.

Senator Grosart: But they are losing money.

Sentor Cameron: Right.

Senator Grosart: They are almost broke.

Mr. Archer: They are losing hundreds of millions of dollars; they have a huge deficit.

Senator Bourget: Turning to your research staff, Mr. Archer, what is the turnover in your research staff?

Mr. Archer: Correct me if I am wrong here, but I think that when we recruit university recruits, after five or seven years we have lost about 40 per cent of them.

Senator Bourget: Where do they go?

Mr. Archer: They are usually offered other jobs, but sometimes they want to move. It is a matter of gaining more experience with different companies.

The Chairman: Would they go to the United States or to CPR?

Mr. Archer: To my knowledge they do not go to the United States, and I do not think they go to CPR. They go to other companies, not necessarily railways because much of our work can apply in other fields. To our knowledge they do not go to the States. I know that two or three have gone to the Government here.

Senator Bourget: There is no "brain drain" to the United States?

Mr. Archer: Not to our knowledge.

Senator Bourget: From your branch?

Mr. Archer: Not from our branch.

Senator Bourget: Are you also getting to work for you some Americans who have made special studies in the United States? Are you getting some of them?

Mr. Archer: We could through the AAR. We are members of the Associated American Railways and if we have specific problems we could go and study with them. I might say they come to us at times and look at certain problems. I think on our staff there is one young American.

Senator Bourget: We know that MIT, for instance, is engaged in a great deal of study on transportation. Do you send some of your researchers or scientists to universities like MIT which is conducting some applied research in their own laboratories. Are you sending some of your scientists?

Mr. Archer: Usually we have access to the work done in the railways in the United States. They have quite an open door with us, because we are not competitors for their traffic. We do have arrangements with railways in Europe. For instance, we can send someone to British Railways for a month at any time to study specific problems, or to the French National Railways. We have the Athlone Scholarship and we recommend Canadians for that, for two years study in England at universities and with industry. We usually have one or two every year going over there. As a matter of fact, we have one who is coming back this summer who has just finished his Ph.D.

The Chairman: Are you doing any work on hovercraft?

Mr. Archer: We are not doing any work on hovercraft. We are discussing with them. I have ridden in hovercraft and a number of our people have been on them. In England, some of our people on an Athlone Scholarship visited the hovercraft factory, and one of our vice presidents went to the hovercraft factory in England last year. Some experiments in testing hovercraft were conducted at Churchill in winter conditions. We had two people there to observe it, to see the operating conditions and so on. We do not enter that field.

The Chairman: Do you think there is any future for the hovercraft as a means of land transportation?

Mr. Archer: Well, it is an amphibious piece of equipment.

Senator Robichaud: What about the Northumberland Strait crossing?

Mr. Archer: There has been talk about it, but that is not our responsibility in a way. There is possibly some future for it up north. We were looking at various places where we could use it. Wherever a river or something like that has to be crossed in very bad winter conditions it would be useful. Also where it would be extremely expensive to build a railway line.

The Chairman: You do not think it might some day compete with the railways?

Mr. Archer: We do not see it just now. We see the use of faster trains. I do not know the exact speed of the hovercraft; I think it is about 80 miles an hour maximum speed. It is still a fairly heavy vehicle. On the other hand, a train like the turbo is good for 125 miles an hour, and we have got the rail and right-of-way already there.

Senator Bourget: I was reading an article on new transportation technology by Howard R. Ross, in which it is asserted that air-cushion trains will reach speeds of between 200

and 500 miles per hour. It has not been reached yet, but it is coming. MIT is conducting research on that too.

Mr. Archer: Yes, the aero-train that I travelled on at about 160 miles an hour was a French one. They said they had gone up to 212 miles an hour the week before. We could not go faster when I travelled on it because it was foggy and they could not apply the brakes quickly enough. Apparently there is no limit to the speed if you put enough power behind it, and you could reach speeds of 200 to 300 miles an hour. There is also the question of the operating costs involved, which would have to be looked at very carefully.

The Chairman: You speak about the research problem which exists in relation to soil dynamics and you say on page 4 that you spend about $150 million per annum in just maintaining your railway right of way. In terms of research there do you do your research within the CNR on this?

Mr. Rennie: We do a very limited amount of research in soil mechanics, again to solve each day to day problems associated with our right of way. It has close liaison again with the National Research Council that has a division of building research and has quite a strong soils mechanics group. There is of course a great deal of research in this area being done in the United States which we will be able to use, but we feel that because in Canada, with our climatic conditions and particularly because the railways are likely to play an expanding role in northern Canada where the problems of soils mechanics will be certainly quite severe and perhaps unique to this country, that again there is a need of co-ordination of the work that is going on in universities, in the railways and in government to avoid duplication of efforts and to decide where we should put our efforts into this area.

The Chairman: Have you been in communication or have you been co-operating with the Department of Energy, Mines and Resources?

Mr. Rennie: Through the National Research Council.

The Chairman: That is a round-about method.

Mr. Rennie: Most of our dealings in the technical field have historically been through the National Research Council more than through the Department of Energy, Mines and Resources.

The Chairman: It would seem to me this would be a field of research which would fit much more the natural vocation of the Department of Energy, Mines and Resources than NRC.

Mr. Rennie: I believe the research in the NRC has been its association with the construction industry and that is primarily why they have developed that soils research section. As I say, we feel again a need for co-ordination and avoidance of duplication of work and a need for expanded research in this area, particularly for northern Canada.

Senator Bourget: You are not sure, up to now, that the amount of research being made on soil mechanics or soil dynamics by the National Research Council is sufficient to meet your needs or the information due to climatic conditions or structure that we have to face here in Canada?

Mr. Rennie: I can say that we felt that much is useful, but not all is adaptable, particularly to rail operation, because there has not been too much, specifically for railway right of way or railway roadbeds. It has been done in other areas. Although a lot of it you can translate it is not strictly applicable for railway purposes.

Senator Grosart: That is what the highway people used to say until they discovered differently. They used to say exactly the same thing, that this soil research was not applicable to building highways and they found out to their sorrow that it was.

The Chairman: That it was applicable?

Senator Grosart: Of course it was.

Mr. Archer: We feel the same way.

Senator Grosart: They found out it was applicable after they built thousands of miles of roads that broke up every spring.

The Chairman: You are not referring to Ottawa, because here we break them ourselves!

Senator Cameron: Mr. Chairman, in the building of airport runways they have exactly the same principle as in the building of highways and in the building of railroads. The Department of Agriculture has had a very extensive soil survey program for years. It would not go into the detail that you would want it to for road loads and so on, but certainly they could provide the background

information on the composition of the soil, and that is one of the basic factors you need to know. It would seem to me there must be some place where these three come together, railways, airports and highways because they depend on the same basic information. Apparently there is no direct provision for co-ordination of these three.

Senator Grosart: Yet the CNR is in all three areas. You are in road transportation, rail transportation and air transportation.

The Chairman: They are not responsible for road maintenance.

Senator Grosart: But they are interested. The CNR owns probably the largest trucking company in Canada so they have to be interested in the roads they are driving on.

The Chairman: If they start to build the roads to maintain or improve them they will be in difficulties.

Senator Grosart: Our witnesses have indicated to us that the policy of the railroad has been to wait until someone else develops something. An automotive company developed the diesel and an aircraft company developed the turbo and perhaps the road people are waiting for the CNR to come along and do some road research.

The Chairman: I think you are a bit unfair in your summing up.

Senator Grosart: I just said perhaps they were. I do not think I am being unfair, because I was going to mention it. I read this amazing statement here in Appendix No. I. Whoever put it together is certainly a master of the short answer. One of the guideline questions asks "What is the relationship between the agency's responsibilities and powers and its activities and programs?" The answer is "Not applicable".

Senator Cameron: There is a lot of that in the brief.

Senator Grosart: The CNR says there is no relationship whatsoever between whatever responsibilities or powers it may have and its scientific activities and programs.

Mr. Archer: I would have to see the original. I do not remember the question; it sounds a little funny.

Senator Grosart: You paraphrased the question yourself, the relationship between the agency, that is the responsibilities and powers and its activities and programs, obviously scientific activities. The next two answers surprised me too, but I will not go into them. The next two "Not applicable" answers surprised me. You have no major hindrances and no major changes in organizational functions in the next five years. Perhaps it is merely the danger of too short an answer.

The Chairman: I suppose that the brief was not written and prepared by an economist!

Senator Grosart: I merely mention that in passing to suggest—I am not trying to be unfair.

Senator Cameron: May I comment on the brief in this way, that I think in one way it falls far short of what we want in a very simple area, that is the numbering of the pages. It is very difficult to relate one thing back to another. For example, when you get to the appendix, the pages are not numbered at all and if you want a cross reference, as we do in the committee, you have to look all over the place; or set up your own numbering system, which is what I did.

Mr. Archer: What numbering is that, sir?

Senator Cameron: There is no page numbering on the appendices. It is only a small point, but in terms of convenience it is rather annoying, sometimes.

Senator Grosart: I think, senator, in fairness, I would say this has applied to a good many of the briefs and I would be inclined to excuse it, in that it did throw quite a burden on our witnesses, with the guidelines.

The Chairman: Perhaps you might want to revise this before it goes into our Proceedings.

Mr. Archer: We could revise those questions?

The Chairman: At least, review them and, dependent on your answers, you might have to come back.

Senator Grosart: This is once we will allow a major alteration in our Proceedings.

The Chairman: Would it be true to say that, in so far as your relations with Government research agencies are concerned, up to now at least you have communicated only with the National Research Council.

Mr. Rennie: I would say mainly, although we have had a large number of communications with the Department of Health and Welfare, and some with the Department of Mines on specific problems.

The Chairman: Yes, for instance with the Department of Mines, when you have to build a railway as an access service to a mine, of course.

Mr. Rennie: There is a railway committee which has a number of subcommittees, and there is an associate committee on railway problems with the NRC. For instance, there is a railway diesel engine located here in Ottawa, which we have loaned to the NRC.

The Chairman: Where it will stay, until it is transferred to a museum of some kind?

Mr. Rennie: I think the engine was for test purposes of some kind. It would not be useful as a locomotive at any time.

Senator Bourget: Is there any relation between your branch and the telecommunications branch of the Department of Transport, because you are interested in telecommunications?

Mr. Archer: In telecommunications, we do not do any research for them. We do our own research. I am sure there is a relationship, but I cannot tell what relationship exists between them and the Department of Transport.

Senator Bourget: You also have a planning branch which, I suppose, will look into the priorities. How are those priorities established for research?

Mr. Archer: On the urgency of the project, and if it is a matter of safety, it has immediate priority, and on the benefits that we expect to derive from the research we proceed with; or it could be, if it is long-term research and we get other problems we feel are a little more urgent, we can put it aside until we feel we can tackle that problem.

In the planning branch we look five or six years ahead and try to establish what type of transportation we should have for the markets that we serve—for instance, a solids pipeline is one of those. I might point out that, all over, we are not doing research in these advanced fields of new vehicles. We are not manufacturers and we would have a very limited market if we had them. Maybe we are somewhat comparable to the commercial air lines. They don't do research on jet engines and other engines; it is done by manufacturers who sell them to them, and to that extent I think we are somewhat similar to them.

Senator Grosart: They seem to participate rather more in the fundamental research. Perhaps I am speaking more of the United States where the situation is entirely different and where they start off with a government project for which the government provides the money and they all participate. Perhaps it is not a fair comparison.

Mr. Archer: It is rather like the situation with the Concorde. I think a lot of people will buy the Concorde but they had nothing to do with the research.

The Chairman: You are behaving more as a user than in the research field.

Mr. Archer: As a user, and of course we may modify them after we have had experience of testing them.

Senator Cameron: Mr. Budd does your work?

Mr. Archer: Mr. Budd has done much of our work. We cannot compete; we are not in the same field.

The Chairman: There has been some research done by the NRC on a gas turbine locomotive system. Is this connected with any of your problems?

Mr. Rennie: No, I believe this has been terminated. This was an attempt to apply the use of coal as a primary fuel for gas turbines. I think it was done by Dean Mordell at Macdonald College in Montreal. However, that has been terminated, I believe, because of technical problems that they ran into in the design of the turbine.

Senator Bourget: I have a last question and I think it may be unfair. Have you given any thought to the idea of co-ordinating the whole

field of research in Canada either by appointing a Minister of Science Policy or other body which would supervise and co-ordinate the whole research field in Canada. If you think it is an unfair question, don't answer.

Mr. Archer: I haven't given a thought really to the question of the appointment of a minister. Any view I would express here would be purely personal.

The Chairman: Not the result of research.

Mr. Archer: Not the result of research and it would be on the spur of the moment.

The Chairman: I think this is a good time to adjourn, but before doing so I want to thank both of you gentlemen very much for spending the afternoon with us.

The committee adjourned.

APPENDIX 20

BRIEF
TO THE SPECIAL COMMITTEE ON SCIENCE POLICY
OF THE SENATE OF CANADA
BY
THE DEPARTMENT OF RESEARCH AND DEVELOPMENT
CANADIAN NATIONAL RAILWAYS

1. Canadian National Railways is a transportation company securely based in science and engineering and operating as a vital element of our commercial and industrial society. CN is one of the world's largest transportation organizations. In addition to its 25,000 miles of mainline track, which is more than any other railway outside of the Soviet Union, it operates a fleet of coastal vessels, trucking subsidiaries, telecommunications networks involving telegraph, radio, television and teletype transmissions and a chain of hotels. With approximately 85,000 employees, it is the largest corporate employer in the country.

2. Historically, CN has always been science and research oriented. From amalgamation in 1923 to the end of the second world war, some form of organized scientific research activity was maintained, mainly in the economic research field. With the rapid advancement of technology following the war, CN substantially expanded its research capabilities in engineering, technology and in the physical sciences by the establishment of research laboratory facilities, in 1945. During the fifties, expansion of R. and D. effort was continued in the economic and physical sciences disciplines and new disciplines, particularly the operations research group, were added to the R. and D. effort. In 1964, the Company, in recognition of the importance of research in technology and the natural sciences, constructed a new technical research center in Montreal, one of the most modern in the transportation field.

3. The resources expended for research by CN in the disciplines of interest to the Special Committee represent major

expenditures compared to those generally applied to transportation research in North America. In fact, they are among the largest of all expenditures for research among North American railroads.

4. The above is not intended, however, to imply a satisfactory level of research effort in Canada in the transportation field. It should be realized that the railways are a strong growth industry in Canada as evidenced, in part, by the fact that CN alone has expended in excess of three-quarters of a billion dollars for new plant and facilities in the past 5 years. Extensive new line construction is likely to continue, particularly in northern Canada. It is also significant that transportation services (excluding private automobiles) represent approximately 6% of the gross national product and, therefore, transportation costs constitute an important portion of the physical distribution costs of manufactured goods and other commodities in this country. It is obvious that research which contributes to a reduction in the cost of railway and other transportation operations will inevitably be reflected in minimum costs of transportation to manufacturers and shippers and no elaboration is needed of the beneficial effects of the lowest possible costs of transportation in Canada's position in the export market place.

5. Virtually all of the research conducted by CN in the past, with resources available in-house in the Company, has been relatively short range applied research and development devoted to solving immediate and short term problems and seeking innovation in design of equipment and services. CN has, however, participated with other transportation organizations in much useful work with various Federal agencies, universities and scientific institutions, again in mainly short range applied research projects, but also to a limited extent on more long

range fundamental studies. Outstanding in such work has been the programs of engineering studies of the Associate Committee on Railway Research of the National Research Council of Canada, studies on woodchip pipelines with the Pulp and Paper Research Institute of Canada, studies on solids pipelines at the Research Council of Alberta, co-operative work on railway materials with the Forest Products Research Laboratories and studies of air pollution problems and transportation of radioactive materials with the Department of National Health and Welfare.

6. Since 1967, the passage by Parliament of the Industrial Research and Development Incentive Act for promotion of research in engineering and natural sciences has provided valuable assistance to CN's in-house research efforts in these fields. However, because of the importance of transportation to the economic and social welfare of Canada, it is considered that several significant steps could be taken to enhance research in the transportation field, having particular regard to railway operations. Among these are:

7. Increased Participation of Universities, Provincial Research Councils and Other Research Organizations with Industry in Scientific Research in the Transportation Field

There is no doubt that increased participation of Universities, Provincial Research Councils and Research Institutes, particularly in long range fundamental studies which cannot at present be supported by resources available to the industry, would enhance scientific research in the transportation field in Canada. Several formats could be suggested to obtain such participation. One which appears to offer considerable appeal would be the formation of a National Transportation Research Council. Such an agency would stimulate teaching and research activities in transportation at Universities, Provincial Research Councils, in

industry and in other research bodies and would encourage co-ordination of such activities among the groups involved. It would seem desirable that to be most effective and to avoid duplication of effort Universities, Provincial Research Councils, other Research bodies and industry should participate in areas of research of their particular expertise and interest, rather than attempting to encompass the entire field of transportation research at one institution.

CN's research effort has been devoted, naturally, to railroad problems or to areas where it has a direct interest or influence. Many problems, however, involve intermodal activities which lie beyond CN's direct ability to influence and require a broader approach than CN can provide by itself from its own resources and hope to solve in isolation from the transportation industry in general. It is in these areas where it is believed that a National Transportation Research Council would play a very significant role.

8. Increased Participation of Federal Agencies

The valuable contribution of various Federal agencies, particularly in the areas of engineering and technology and the physical sciences, has already been mentioned. No doubt the contribution made by such agencies could be fostered and extended under the stimulation of the National Transportation Research Council.

9. Broadening of the Scope of Federal Assistance to Research in Industry

As mentioned earlier, the industrial research and development incentives of the Department of Industry have and are continuing to make an important contribution to CN's efforts in research in engineering and the physical sciences. However, equally important in an industrial environment are the methods and systems and the economic criteria by which technological knowledge and advancements are applied to transportation

operations in terms of productivity and minimum costs. It, therefore, seems logical that incentives now applied for scientific and technological developments should be available for operational and economic research on projects which support specifically the implementation of technological innovation and systems approach.

10. Establishment of a National Organization for Research in Soils Dynamics

Maintenance of railway right-of-way constitutes one of the largest items of expense in railway operations, amounting in CN to some $150,000,000 per annum. Over the years, while continual improvements have been made in individual components such as ballast, ties, rail and track fastenings, little research has been carried out on the total roadbed structure as a dynamic system of which soil is a major component. With increasing speeds and loads of modern freight movements, there is an urgent need of basic research to establish scientific criteria for construction and maintenance of the most economic railway roadbed. Also, it will be recognized that in a country such as Canada with climatic conditions ranging from sub-tropical to arctic and with virtually every known type of geological and earth structure, roadways are required to be constructed and maintained under an extremely wide variety of physical conditions. The problems encountered with railway roadbed such as frost heaving damage, selection of fills, slope erosion, etc. are in most instances common also to highway and airport construction and maintenance.

Because the research involved covers all modes of transport, it is believed that it should be undertaken only on a national scale with participation by industry and government agencies. The returns from research in this area, however, are likely to be so large as to have a most significant and beneficial effect on the overall economics of transportation in future years.

Research in this area would have strongly beneficial implications from a national defence viewpoint and would serve the country as a whole.

A preliminary proposal to this effect has already been presented by CN and the National Research Council of Canada through the Science Secretariat to the Science Council of Canada.

11. Establishment of a Transportation Research Information Center

In order to co-ordinate and disseminate information generated by scientific research activity, so that results of research carried out at home and abroad can be brought to bear quickly on railway and other transportation problems, a transportation research information center should be established, possibly in conjunction with the organization suggested in 7.

Respectfully submitted,

M. Archer,
Vice-President,
Research and Development.

APPENDIX TO BRIEF
TO THE SPECIAL COMMITTEE ON SCIENCE POLICY
OF THE SENATE OF CANADA
BY
THE DEPARTMENT OF RESEARCH AND DEVELOPMENT
CANADIAN NATIONAL RAILWAYS

Prepared in accordance with the "Guide for Submission of Briefs and Participation in Hearings" - part II, "Specific guidance for agencies of the Federal Government." Section numbering and lettering correspond to those used in the "Guideline".

APPENDIX I

2.1 Organization

(a) Organizational Block Diagram (attached as Exhibit 1A).

(b) Parliamentary reporting channel - CNR reports through the Minister of Transport.

(c) Block diagram indicating organization showing division responsible for scientific activities (attached as Exhibit 1B).

(d) Formal agreements regarding scientific activities between agency and organizations outside of Canada including foreign governments or their agencies.

None

(e) Overseas offices of agency dealing with scientific affairs.

None

2.2 Organizational Functions

(a) Agency's statutory functions and powers regarding scientific activities.

None

(b) Organizational policies as a result of (a) that could be considered to define agencies "science policy".

Not applicable

(c) Based on (a) and (b), organizations responsibility in relation to other federal agencies, industry, educational institutions and international representation and the monitoring of scientific activities outside of Canada.

Not applicable

(d) Process whereby operational effectiveness, duties and goals are reviewed or revised.

Operational effectiveness is assessed by management on the basis of innovations created by the group in terms of safety of operations and economic benefit to the organization. Duties and goals are reviewed and revised depending on changes in demand for research by operating groups in the Company.

(e) Outside studies commissioned (last 5 years) to suggest improvements in operating procedures.

During the period 1962-1965 the Company joined with six other railroads to sponsor a one-million dollar research study at Battelle Memorial Institute, Columbus, Ohio. The purpose was to develop a computer simulation of a railroad system.

(f) Relationship between agency's responsibilities and powers and its activities and programs.

Not applicable

(g) Major hindrances to the effective performance of functions and the honoring of responsibilities and powers.

Not applicable

(h) Major changes in organization functions forecast as probable or desirable during the next 5 years.

Not applicable

2.3 Personnel Policies

(a) Steps taken to identify and hire those members of university graduating classes who will be the most effective researchers.

Recruitment carried out at all major Canadian Universities by qualified professional scientists and engineers and personnel officers.

(b) Unique criteria developed (or any research initiated to develop criteria) to help identify those who will be creative and effective researchers.

No, but attempts made to recruit in upper 10% of graduating class consistent with their interest in research. Also those who have demonstrated research abilities, e.g. Athlone scholars are actively recruited.

(c) Steps taken to identify those members of staff with high potential as research administrators.

On job observation, from intra-mural Management Inventory and Appraisal Program, intra-mural Management Training Program.

(d) Distinction made between administrators of research and researchers.

None

(e) Policy regarding intra-mural and extra-mural education for staff members conducting or administering research.

Intra-mural staff development programs. Extra-mural financial assistance to staff in selected cases.

2.4 Distribution of Activities

Not applicable; scientific activities are applicable on a total system basis applying equally to all sections and regions of Canada.

2.5 Personnel Associated with Scientific Activity

(a) Current personnel establishment and people on strength by category or personnel.

See Exhbit 2A

(b) Number of above professional staff devoting most of their time to administrative duties.

Four

(c) Professional staff associated with scientific activities according to degree level.

See Exhibit 2B

(d) to (h) inclusive. Total number of professional staff in each degree category for each of the years 1962 to 1968, inclusive, and estimates for each of the years 1969 to 1973; percentage of turnover of professional staff in the three degree categories for each of the years 1962 to 1967; percentage of professional personnel who since graduation, (i) have been employed in industry at one time, (ii) have been on the staff of universities, (iii) provincial departments or agencies or (iv) other federal agencies; number of staff in each category on education leave; number of university students given summer employment in the field of scientific activities for the years 1962 to 1967.

See Exhibit 2C "Professional Staff History".

2.6 Expenditures Associated with Scientific Activities

(a) Functions

All expenditures associated with scientific activities are on (1) intra-mural R&D and (4) testing and standardization.

Scientific Discipline

See Exhibit 2 D attached.

Areas of Application

All expenditures associated with scientific activities are on (6) Transportation Research.

(b) Operating and capital funds expended for the fiscal years 1962 to 1967 inclusive.

See Exhibit 2 D.

Estimated operating and capital expenditures for 1968 and forecasted for the period 1969 to 1973 inclusive.

See Exhibit 2 E.

(c) Funds expended to further professional university education of staff for each of the fiscal years from 1962 to 1968, inclusive.

Approximately $10,000 per annum expended for further professional university education of staff.

2.7 Research Policies

(a) Units concerned with intra-mural research activities.

(1) Process whereby various types of programmes and projects are selected, initiated and monitored.

Projects are initiated by the various operating departments and general management of the Railway and from within the R&D group itself.

(2) Establishment of Priorities between programmes and projects.

Priorities are established by safety of operations considerations and anticipated economic benefit to the Company, both long and short term.

(3) Application of methods such as Critical Path Network or Programme Evaluation and Review Technique (CPN or PERT) to plan and monitor programmes and projects.

These techniques are used extensively. Recent applications of CPM at CN are:

(i) Planning pick-up and delivery control system in Express.

(ii) Relocation and construction of rail lines in the Niagara Peninsula required by the construction of the new Welland Canal.

(iii) Maintenance of work equipment and scheduling of operations in the St. Henry Shops.

(iv) Planning of the hump yard and re-layout of the Calder Yard in Edmonton.

(v) Planning of facilities and procedures in the Concord Express Terminal (Toronto) for the handling of containerized express (CN-Manchester Lines containerization project).

(vi) Management Information Study plans.

(vii) Renovation of cafe-lounge passenger cars in Point St. Charles car shops.

(viii) CN Purchasing and Stores non-stock purchases study.

(4) Use during last five years (and currently) of contracting out projects in support of intra-mural programmes.

No contracts have been undertaken.

(5) Policies regarding the funding of extra-mural research programmes in the universities and industry.

No specific policies. In the few cases over the past years where work has been contracted to universities, it has been done on the individual needs and merits of a particular project.

(6) Shifting of research resources from one program to another on termination of programmes or project.

This is carried out by considering each case on its individual merits considering the particular needs of the Company at any given time.

(7) Transferring of results of intra-mural research to those having potential need of them.

Through the usual channels of

(a) Publication in technical journal
(b) Submission of reports
(c) Presentation of papers at professional Society meetings.

(b) Units exclusively concerned with extra-mural research activities.

Not applicable.

2.8 Research Output

(1) Patents arising from research activities, number of licenses granted and value of resulting production in Canada and elsewhere.

As follows:

Year	Patents	Licenses Granted	Value of Production
1962	3	Nil	-
1963	1	Nil	-
1964	3	Nil	-
1965	Nil	Nil	-
1966	2	1	not known at this date
1967	4	4	not known at this date

(2) Books or journal articles arising from research activities.

Approximately 8 to 10 journal articles on various projects in engineering and natural science disciplines are published annually.

(3) Reports issued from unit.

Approximately 50 major research reports and séveral hundred internal reports are issued annually on intra-mural research activities.

(4) Conference or other means used to transfer information regarding the results of a project or programme to extra-mural groups.

Approximately 5 to 10 major technical papers are presented annually covering various projects in engineering and natural science disciplines at various conferences of technical societies.

(5) Means of transfer of scientific and technological data obtained from countries outside Canada to extra-mural group.

Through world-wide associations with various Railway, international organizations such as the International Union of Railways in Europe and the Association of American Railways, means are available for transfer of information to and from extra-mural groups and Federal Agencies such as the National Research Council.

(6) Individuals who had the opportunity to train in specialized fields while employed with CN and subsequently left and made important contributions to their field.

CN has the largest transportation research unit in Canada with strong emphasis on technical economic and operational research. Many employees, who have undoubtedly benefited from their experience in CN, are now occupying senior positions in Canadian Industry, universities and federal agencies.

(7) Research teams that have arisen in this period who have unique and valued abilities in important fields.

As follows are examples:

(a) Electronic research team in the application of electronics to Railway technology.

(b) Vehicle dynamics team in the study of dynamics of railroad rolling stock.

(c) Environmental research team in the application of modern environmental control techniques to transportation of perishable products.

(d) Protective coatings research team which is outstanding in the application of modern coating technology to the Railway environment.

(e) Computer Simulation of Railroad Operations - This team was one of the first of its kind in North American railroading and has pioneered many developments in this field.

(f) CPM Team - This team has done a considerable amount of work both in the development and application of CPM techniques to a very wide range of problems. Its members are frequently called upon to give courses to other companies and at universities.

(g) Cybernetic Control - This team has been active in developing better control systems and is now taking an active part in the development of an improved management information and control system for the company.

(h) Industrial Engineering Standards Team - This team has specialised in the development and application of pre-determined work standards for productivity control purposes.

(i) Research team on Railway costing methods.

(8) Unique or valuable research tools, facilities or processes developed during the period 1962-1967.

See Exhibit 2 F

(9) and (10) Impact of scientific activities and research output on advancement of scientific knowledge and Canadian economic development.

See Exhibit 2 F

2.9 Projects

(1) Scientific Activities - years 1962 - 1967.

See Exhibit 2 F

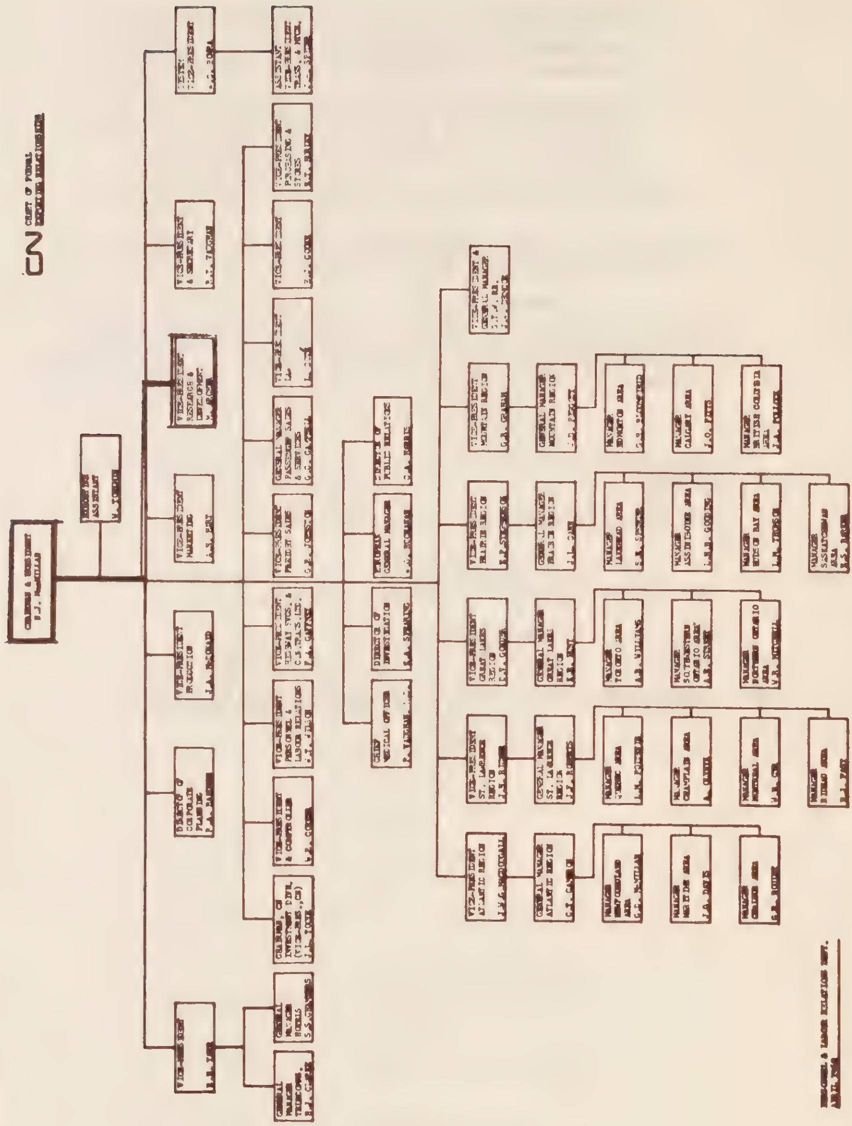
(2) Significant Completed Projects - 1962-1967.

See Exhibit 2 F

2.10 Organizations not currently engaged in scientific activities

Not applicable.

Exhibit No. 1(a)



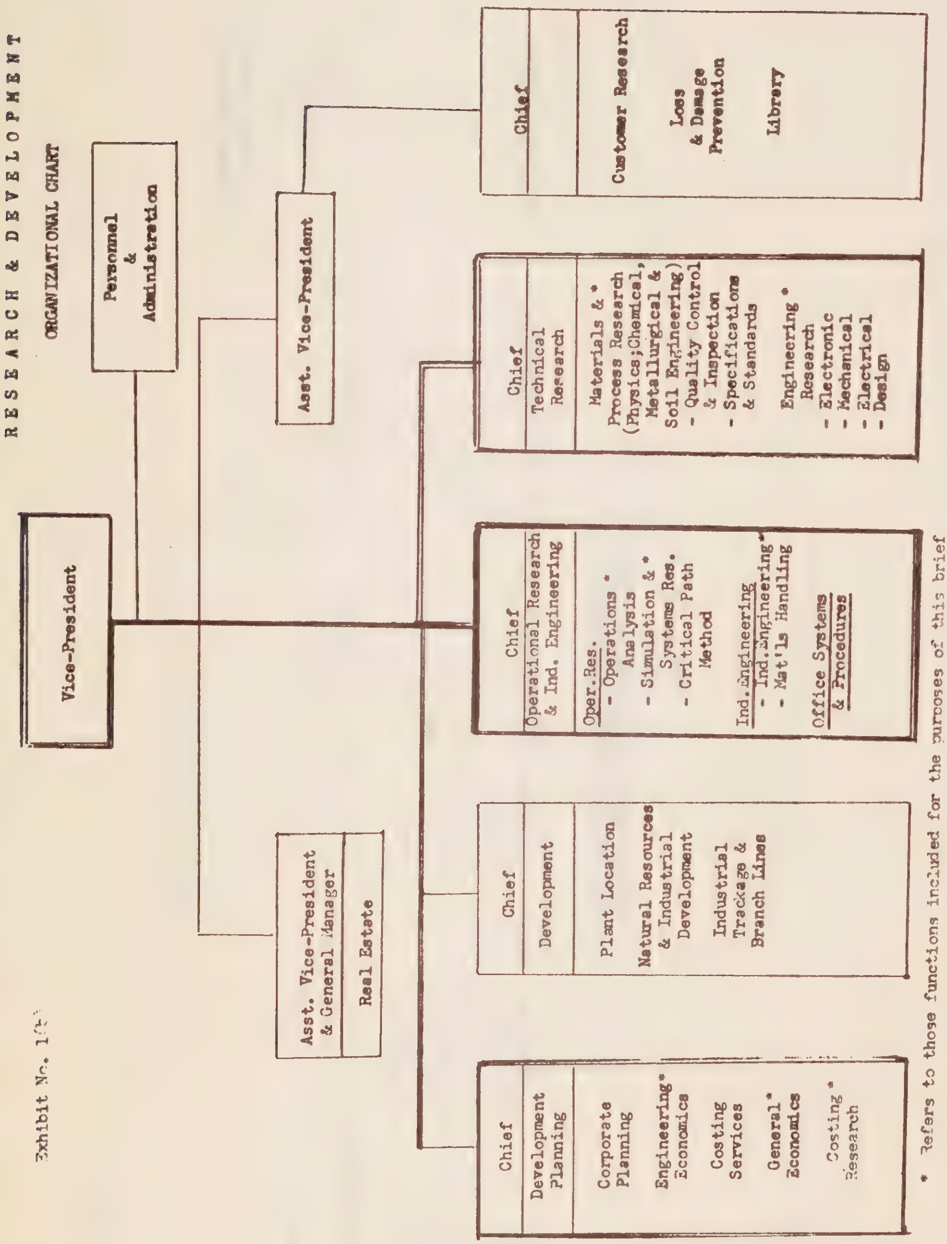

RESEARCH & DEVELOPMENT
ORGANIZATIONAL CHART
Exhibit No. 1[?]
Vice-President
Personnel & Administration
Asst. Vice-President
Asst. Vice-President & General Manager
Real Estate
Chief
Customer Research
Loss & Damage Prevention
Library
Chief
Technical Research
Materials & * Process Research (Physics;Chemical, Metallurgical & Soil Engineering)
- Quality Control & Inspection
- Specifications & Standards
Engineering * Research
- Electronic
- Mechanical
- Electrical
- Design
Chief
Operational Research & Ind. Engineering
Oper.Res.
- Operations * Analysis
- Simulation & * Systems Res.
- Critical Path Method
Ind.Engineering
- Ind.Engineering*
- Mat'ls Handling
Office Systems & Procedures
Chief
Development
Plant Location
Natural Resources & Industrial Development
Industrial Trackage & Branch Lines
Chief
Development Planning
Corporate Planning
Engineering* Economics
Costing Services
General* Economics
Costing * Research
* Refers to those functions included for the purposes of this brief

EXHIBIT 2 A

CURRENT PERSONNEL ESTABLISHMENT AND PEOPLE ON STRENGTH BY CATEGORY OF PERSONNEL

	Technical Research	Operational Research	Industrial Engineering	Development Planning
Professionals	44	16	9	33
Technicians	42	2	-	-
Workers	3	-	-	-
Other Supporting Personnel	9	1	1	28
Totals	98	19	10	61 *

* not wholly engaged in economic research

EXHIBIT 2 B TECHNICAL RESEARCH

PROFESSIONAL STAFF ASSOCIATED WITH SCIENTIFIC ACTIVITIES ACCORDING TO DEGREE LEVEL

		(i)	(ii)	(iii)	(iv)		(v)	(vi)
Degree	Number	Country of Birth	Country of Secondary Education	Country of University Degree	Years from Graduation	Years in Present Organization	Average Age	Percentage operating in 2 official languages
Bachelor	37	1 Estonia 2 Latvia 1 Germany 1 Great Britain 1 Egypt 1 Austria 1 Poland 29 Canada	1 Estonia 2 Latvia 1 Germany 1 Great Britain 1 Egypt 1 Austria 1 Poland 29 Canada	1 Estonia 2 Latvia 1 Germany 1 Great Britain 1 Egypt 1 Austria 1 Poland 29 Canada	0-5, 11 5-10, 8 10-15, 4 15-20, 7 more than 20, 7	0-5, 11 5-10, 10 10-15, 6 15-20, 3 more than 20, 7	38	30%
Master	5	Canada	3 Canada	2 Canada 3 Great Britain	0-5, 3 5-10, - 10-15, - 15-20, - More than 20, 2	3 - - - 2	36	20%
Doctorate	2	Canada	2 Canada	2 Great Britain	0-5, 1 5-10, 1 10-15, - 15-20, - more than 20, -	8 8 - - -	34	Nil

EXHIBIT 2 B

PROFESSIONAL STAFF ASSOCIATED WITH SCIENTIFIC ACTIVITIES

ACCORDING TO DEGREE LEVEL

		(i)	(ii)	(iii)	(iv)		(v)	(vi)
Degree	Number	Country of Birth	Country of Secondary Education	Country of University Degree	Years from Graduation	Years in Present Organization	Avg. Age	Percentage Operating in 2 official languages
- OPERATIONAL RESEARCH								
Bachelor	8	7 Canada 1 Israel	8 Canada	8 Canada	0-5, 5 5-10, 1 10-15, 2	0-5, 5 5-10, 1 10-15, 2	30	35%
Master	6	3 Canada 3 U.K.	3 Canada 3 U.K.	3 Canada 3 U.K.	0-5, 2 5-10, 3 10-15, 0 15-20, 0 > 20, 1	0-5, 2 5-10, 3 10-15, 1 15-20, 0 > 20, 0	34	50%
Doctorate	1	1 Canada	1 Canada	1 Canada	15-20, 1	10-15, 1	38	100%
- INDUSTRIAL ENGINEERING								
Bachelor	3	2 Canada 1 Belgium	2 Canada 1 Belgium	2 Canada 1 Belgium	0-5, 1 > 20, 1 15-20, 1	0-5, 3	40	65%
Master	1	1 Australia	1 Australia	1 Canada	5-10, 1	0-5, 1	39	0%

EXHIBIT 2B - DEVELOPMENT PLANNING

PROFESSIONAL STAFF ASSOCIATED WITH SCIENTIFIC ACTIVITIES ACCORDING TO DEGREE LEVEL (INCL. PART-TIME ASSN.)

		(i)	(ii)	(iii)	(iv)				(v)
Degree	Number	Country of Birth	Country of Secondary Education	Country of University Degree	Years from Graduation		Years in Present Organization		Percentage operating in 2 official languages
		1 Great Britain	1 Great Britain	2 Great Britain	0-5	17	0-5	15	30%
		2 Hungary	2 Hungary		5-10	5	5-10	6	
Bachelor	26	1 Egypt	1 Egypt	1 Canada	10-15	1	10-15	1	
		1 Poland	1 Italv	1 Italy	15-20	-	15-20	-	
		21 Canada	21 Canada	21 Canada	20 plus	3	20 plus	4	
				4 Canada	0-5	4		4	
Master	6	4 Canada	5 Canada	1 Great Britain	5-10	-		-	20%
		1 USA ,	1 Great Britain	1 USA	10-15	1		1	
		1 Belgium			more than 20	1		1	
Doctorate	1	1 Hungary	1 Hungary	1 Hungary	10-15	1		1	-

EXHIBIT 2 C TECHNICAL RESEARCH

PROFESSIONAL STAFF HISTORY - YEARS 1962 to 1968
AND ESTIMATED YEARS 1969 - 1973

Degree Category	Year	Total Number of Employees	% Turnover Years 1962-1967	Percentage of Current Professional Staff at one time: Employed in Industry	On Staff of Universities	Provincial Depts or Agencies	Other Federal Agencies	No. on Education Leave	No. of Summer Students 1962-1967
	1962	45	Approx. 10%						1962 - 5
	1963	45	" 10%						1963 - 5
	1964	45	" 10%						1964 - 5
	1965	44	" 10%						1965 - 3
Bachelor	1966	43	" 10%	Not					1966 - Nil
	1967	43	" 10%	Applicable	Nil	3%	3%	Nil	1967 - Nil
	1968	44							
	(1969	45							
	(1970	46							
Estimated	(1971	47							
	(1972	48							
	(1973	49							
	1962	3	Nil						
	1963	4	Nil						
	1964	4	Nil						
	1965	4	Nil						
Master	1966	4	Nil	Not					
	1967	4	Nil	Applicable	Nil	Nil	20%	1	-
	1968	5	20%						
	(1969	5							
	(1970	6							
Estimated	(1971	6							
	(1972	7							
	(1973	7							

EXHIBIT 2 C (Cont'd.)

Sheet 2

PROFESSIONAL STAFF HISTORY - YEARS 1962 to 1968
AND ESTIMATED YEARS 1969 - 1973

Degree Category	Year	Total Number of Employees	% Turnover Years 1962-1967	Percentage of Current Professional Staff at one time: Employed in Industry	On Staff of Universities	Provincial Depts. or Agencies	Other Federal Agencies	No. on Education Leave	No. of Summer Students 1962-1967
	1962	1	Nil						
	1963	1	Nil						
	1964	1	Nil						
	1965	1	Nil						
Doctorate	1966	1	Nil	Not					
	1967	1	Nil	Applicable	50%	Nil	Nil	1	-
	1968	2							
	(1969	2							
	(1970	3							
Estimated	(1971	3							
	(1972	3							
	(1973	4							

EXHIBIT 2 C

PROFESSIONAL STAFF HISTORY - YEARS 1962 to 1968
AND ESTIMATED YEARS 1969 - 1973

OPERATIONAL RESEARCH

Degree Category	Year	Total Number of Employees	% Turnover Years 1962-1967	Employed in Industry	On Staff of Universities	Provincial Depts. or Agencies	Other Federal Agencies	No. on Education Leave	No. of Summer Students 1962-1967
				Percentage of Current Professional Staff at one time					
	1962	9	20%						1962-0
	63	8	20						63-0
	64	8	20						64-2
	65	11	20						65-2
Bachelor	66	8	20						66-3
	67	9	20	N/A	Nil	Nil	Nil	Nil	67-2
	68	9	20						
	(69	9	20						
	(70	9	20						
Estimated	(71	9	20						
	(72	9	20						
	(73	9	20						
	1962	7	20						
	63	7	20						
	64	8	20						
	65	7	20						
	66	6	20						
Master	67	5	20	N/A	Nil	Nil	Nil	Nil	
	68	6	20						
	(69	6	20						
	(70	6	20						
Estimated	(71	6	20						
	(72	6	20						
	(73	6	20						

EXHIBIT 2 C (cont'd) - Operational Research

SHEET 2

Degree Category	Year	Total Number of Employees	% Turnover Years 1962-1968	Employed in Industry	On Staff of Universities	Provincial Depts. or Agencies	Other Federal Agencies	No. on Education Leave	No. of Summer Students 1962-1967
	1962	1	-						
	63	1	-						
	64	1	-						
Doctorate	65	1	-						
	66	1	-						
	67	1	-	N/A	Nil	Nil	Nil	Nil	
	68	1	-						
	(69	1	-						
	(70	1	-						
Estimated	(71	1	-						
	(72	1	-						
	(73	1	-						

EXHIBIT 2 C

PROFESSIONAL STAFF HISTORY - YEARS 1962 to 1968
AND ESTIMATED YEARS 1969 - 1973

INDUSTRIAL ENGINEERING

Degree Category	Year	Total Number of Employees	% Turnover Years 1962-1967	Employed in Industry	On Staff of Universities	Provincial Depts. or Agencies	Other Federal Agencies	No. on Education Leave	No. of Summer Students 1962-1967
				Percentage of Current Professional Staff at one time					
	1962	2	20%						1962-0
	63	5	20						63-0
	64	5	20						64-0
	65	4	20						65-1
Bachelor	66	5	20						66-2
	67	4	20	N/A	Nil	Nil	Nil	Nil	67-2
	68	4	20						
	(69	6	20						
	(70	7	20						
Estimated	(71	7	20						
	(72	7	20						
	(73	7	20						
	1962	0	20						
	63	0	20						
	64	1	20						
	65	2	20						
	66	1	20						
Master	67	1	20	N/A	Nil	Nil	Nil	Nil	
	68	1	20						
	(69	2	20						
	(70	2	20						
Estimated	(71	2	20						
	(72	2	20						
	(73	2	20						

EXHIBIT 2 C (cont'd) - Industrial Engineering

SHEET 2

Degree Category	Year	Total Number of Employees	% Turnover Years 1962-1967	Employed in Industry	On Staff of Universities	Provincial Depts. or Agencies	Other Federal Agencies	No. on Education Leave	No. of Summer Students 1962-1967
	1962	0	-						
	63	0	-						
	64	0	-						
Doctorate	65	0	-						
	66	0	-						
	67	0	-	N/A	Nil	Nil	Nil	Nil	
	68	0	-						
	(69	0	-						
	(70	0	-						
Estimated	(71	0	-						
	(72	0	-						
	(73	0	-						

EXHIBIT 2C - DEVELOPMENT PLANNING

PROFESSIONAL STAFF HISTORY - YEARS 1962 to 1968
AND ESTIMATED YEARS 1969 - 1973

Total Number of Employees	% Turnover Years 1962-1967	Percentage of Current Professional Staff at one Time				No. on Education Leave	No. of Summer Students 1962-1967
		Employed in Industry,	On Staff of Universities,	Provincial Depts. Or Agencies,	Other Federal Agencies		
1968: Bachelor 26 Master 6 Doctorate 1	Approx. 10%	-	Professionals wholly employed by CN	-		Nil	- in range of 1-6 students
1962-67: Data is not reliable.							
1969-73: A slight increase in MBA degrees.							

EXHIBIT 2 D

DETAILS OF EXPENDITURES AND LABOUR

TECHNICAL RESEARCH

YEAR		CHEMICAL	METALLURGICAL	SOILS MECHANICS	LIBRARY	ENGINEERING	TOTAL
1962	Operating	$105,098.62	$80,643.85	$11,396.01	$7,650.91	$208,060.38	$412,844.82
	Capital	-	-	-	-	-	20,817.30
1963	Operating	107,429.24	80,436.35	12,115.72	8,113.64	251,476.82	459,571.77
	Capital	-	-	-	-	-	219,577.13
1964	Operating	120,294.65	91,150.41	18,894.84	8,497.60	287,811.47	526,648.96
	Capital	-	-	-	-	-	752,125.05
1965	Operating	122,476.33	97,265.78	17,347.07	8,788.44	318,292.25	564,169.87
	Capital	-	-	-	-	-	127,007.65
1966	Operating	150,470.82	84,966.81	19,823.55	9,686.81	292,450.96	557,398.95
	Capital	-	-	-	-	-	135,788.50
1967	Operating	202,141.37	85,721.14	29,205.57	10,724.29	328,370.07	656,163.04
	Capital	-	-	-	-	-	254,948.05

		OPERATIONAL RESEARCH	INDUSTRIAL ENGINEERING	DEVELOPMENT PLANNING
1962	Operating	$182,000	Not Available	$200,000
1963	Operating	212,000	Not Available	215,000
1964	Operating	216,000	Not Available	230,000
1965	Operating	214,000	Not Available	250,000
1966	Operating	255,000	Not Available	275,000
1967	Operating	241,000	Not Available	300,000

EXHIBIT 2 E

ESTIMATED OPERATING AND CAPITAL EXPENDITURES FOR 1968
AND 5-YEAR PROJECTION 1969-1973, INCLUSIVE

YEAR	TECHNICAL RESEARCH		OPERATIONAL RESEARCH		INDUSTRIAL ENGINEERING		DEVELOPMENT PLANNING	
	Operating	Capital	Operating	Capital	Operating	Capital	Operating	Capital
1968	$1,100,000	$87,500	$248,000	Nil	$123,000	Nil	$350,000	$5,000
1969	1,175,000	125,000	260,000	Nil	148,000	Nil	380,000	5,000
1970	1,255,000	150,000	273,000	Nil	156,000	Nil	420,000	5,000
1971	1,345,000	150,000	287,000	Nil	164,000	Nil	460,000	5,000
1972	1,430,000	150,000	301,000	Nil	172,000	Nil	500,000	5,000
1973	1,500,000	150,000	316,000	Nil	181,000	Nil	550,000	5,000

EXHIBIT 2 F TECHNICAL RESEARCH

CANADIAN NATIONAL RAILWAYS
DEPARTMENT OF RESEARCH AND DEVELOPMENT
PROGRAMS OF INDUSTRIAL RESEARCH

INTRODUCTION

As outlined in its application for the year 1966, the CNR is a transportation industry, securely based in science and engineering and operating as an important part of the commercial and industrial society of Canada. Because of the diversity of its operations, including railway, highway and water transportation, as well as hotels and communications, a very wide variety of research programs encompassing virtually all of the fields of industrial research activities and the scientific and engineering disciplines are undertaken to serve the requirements of such a diverse operation.

Again as pointed out in the application for 1966, there can be no doubt that the research programs of the CN are of benefit directly to the industrial and economic welfare of Canada. All programs bear directly on the reduction in cost of railway operations. Such reductions are inevitably reflected in minimum costs of transportation to manufacturers and shippers. No elaboration is needed of the beneficial effects of lowest possible costs of transportation in Canada's competitive position in the export market place. In addition, as CN is a transportation and not a manufacturing industry and as it is the largest industrial consumer of manufactured products in Canada, many of the developments of CN technical research are passed on to industry in the form of new devices, products, processes and materials which are of direct benefit to Canadian industry, both in the domestic and export markets and, therefore, of substantial benefit to the economy of Canada. During 1967, CN continued its policy of encouraging Canadian industry to manufacture devices developed through CN's research. During the year, licenses were granted for three devices to two Canadian firms for manufacture and sale of the equipment on a world-wide basis.

SCIENTIFIC RESEARCH AND DEVELOPMENT FACILITIES

The research facilities of CNR are located on an 8-1/2 acre site at 3950 Hickmore Avenue, St. Laurent, Quebec. They comprise a main research building, approximately 42,000 sq. ft. floor area, an engine and car research building, approximately 6,500 sq. ft. floor area and an inclined impact track and associated structures. The staff involved in scientific research is as detailed in the supporting financial statements and nature of the work in progress is as outlined in the attached descriptions of the research programs. Major equipment available other than normal research instrumentation and apparatus includes a "hot" room area and equipment for research on insulated and refrigerated equipment, analog computers for data analyses, a special computer for research in random vibrations and power spectral density analysis, various dynamometers, transducers and specialized recording equipment for dynamic and stress analysis, a wide variety of electronic test equipment for electronic research, infra-red spectroscopic equipment, controlled temperature and humidity facilities and specialized textile equipment for textile research, gas chromatograph equipment, and a fully instrumented test car for over-the-road measurements of train dynamics. Also available is a fully equipped mobile trailer laboratory for soils research studies and apparatus for direct shear measurements of soils.

DESCRIPTION OF RESEARCH AND DEVELOPMENT PROGRAM

TITLE: Metallurgical Research

OBJECTIVE: To advance metallurgical knowledge of metals and alloys used in the industry for the purpose of achieving more efficient transportation through superior physical properties in locomotive, car and track components.

METHOD: By metallurgical research and metallographic studies of structures associated with heat treatment, alloys, steel-making processes, composition, physical properties and services conditions and by analyses of imposed and inherent stresses.

PROGRESS TO DATE:

The possibility of an augmentation action occurring between the inherent vertical stresses and the cementite which has been detected near the centre of some welds in rails is being explored.

The cementite is suspected of being associated with a segregation of elements near the centre of rails. The probable effects of the degree of segregation and of the nature of the elements within the segregate on the formation of the free iron carbide are being explored.

The successful conclusion of this research work should have a marked effect on the efficiency of train movement over continuous rail formed by butt welding standard 39' lengths.

An exploratory modification in the composition of wrought steel car wheel has been made. The performance characteristics of the modified steel will be studied and applied to further research in the attempt to develop wheels capable of improving transportation costs. This is a step in the overall research project towards radical changes in the metallurgy of wheels to meet the increasing demands on the industry.

Research into the requirements of car bearings has indicated that an improvement in performance could be made by increasing the iron carbide constituent in the component of the journal box that transfers the load to the bearing. A trial number of modified components have been applied in service for observation and study.

TITLES OF INTERNAL FORMAL REPORTS
ISSUED DURING THE PERIOD:

Metallurgical factors associated with a number of failures of welded rail in service.

Causes of and corrective measures for welding defects in 8" high-pressure steam transmission line.

Establishment of safety limitations and metallurgical procedures for the reclamation of freight car side frames and truck bolsters.

NAMES AND QUALIFICATIONS
OF KEY R&D PERSONNEL:

P.M. Gardiner,	B.Sc. (Metallurgical Engineer),	University of Toronto
R.W. West,	B.Sc. (Metallurgical Engineer),	University of Toronto
A. Kirkman,	B.Sc. (Metallurgical Engineer),	Queen's University
E.D. Burdett,	B.Sc. (Metallurgical Engineer),	Queen's University

SOURCE OF FUNDS:

In House and IRDIA grant.

DESCRIPTION OF RESEARCH AND DEVELOPMENT PROGRAM

TITLE: Chemical Research

OBJECTIVE: To advance chemical knowledge in the field of materials science; to achieve optimum chemical properties of materials and processes used in the industry to meet the conditions imposed by a rigorous environment and the demand for more efficient transportation.

METHOD: By performance deficiencies research and chemical developments and studies on a wide variety of materials and processes used in the industry in the fields of protective coatings, ceramics, textiles, elastomeric materials, corrosion, air and water pollution, cleaning and sanitary chemicals, wood preservation, cellulose, paper products and packaging, etc.

PROGRESS TO DATE:

Studies are continuing to develop protective coatings for a wide variety of Railway applications, Included in this program are coatings for covered hopper cars carrying bulk commodities, many of which are highly corrosive in nature, such as the potash movements in Western Canada. This research has and will continue to develop protective coatings and systems which will adequately protect this equipment and provide superiod load release of bulk commodities thereby radically reducing cleaning costs. Also included are coatings for passenger and freight equipment to prolong the life of rolling stock and reduce costs of cleaning and maintenance and ultimately transportation costs. Coating systems for new high speed ground transportation systems are under continuous development. The CN has led and is continuing to be a leader in industry in Canada in the economic application of protective coatings.

Research is continuing into new chemical formulations of water treatments for air conditioning systems and various steam plant installations including small high capacity package boilers. Various formulations are being developed and field evaluated to reduce maintenance costs by reducing sludge and scale formation and prevention of corrosion.

A development program is continuing to provide new and improved formulations for insecticides, sanitary and cleaning chemicals designed specifically for the particular railway environment, but frequently of interest to the chemical industry in general. These include new formulations for cleaning exteriors and interiors of passenger and freight equipment, including those for new types of aluminum sheathed high speed passenger trains, new disinfectants, dishwashing chemicals for passenger meal service cars, new deodorants for passenger sleeping car equipment, new formulations for cleaning highway vehicles, etc.

Studies are continuing on developing improvements to a wide variety of textile materials to meet the requirements of the railway transportation environment, including railroad and water transport and hotels. These include hotel and sleeping car linens, upholstery materials, tarpaulins and other load protective coverings, employees' uniforms and protective clothing and includes application research on most types of new synthetic materials and blends of these materials with natural fibres.

An important research project on the application as a diesel fuel of the primary oil which will be produced from the Athabasca tar sands is continuing. The success of this investigation could result in a very substantial reduction in locomotive operating costs.

Research on methods of prevention and control of air pollution and contamination of natural water supplies from Railway facilities is being continued actively, in line with the increasing awareness of Government and industry of the necessity of controlling these forms of pollution.

Research into the mechanism of depletion of additives in diesel lubricating oil and a method of minimizing the effects of additive and base oil deterioration on engine life is an important and continuing project. Included in this area is research into engine lubricating methods of evaluating engine lubricating oils which can be related to operating conditions in the field.

Continuing developments on improvements to a wide variety of elastomeric materials used in Railway service, which constitute a continuing source of high maintenance costs, are being actively progressed. These include seals and gasketing materials for locomotives, cars, highway and marine equipment, and air, water, steam, fuel and lubricant hose and transfer systems.

Because of increasing difficulties in obtaining adequate supply of solid wood ties in certain areas of Canada, development of substitute ties prepared by lamination and gluing of smaller wood sections is being actively progressed. This development offers the possibility of an incentive to the establishment of secondary industries in areas of the country where suitable small wood stands are available. Research is also continuing in new chemical materials for preservation of wood ties and other timber products.

Investigations of materials and methods of protection of ladings in transit are continuing projects designed to avoid losses to industry through damage to goods both in the domestic and import markets. Research is under way, which will eventually use the latest advanced atomic absorption techniques, for analysis of diesel crankcase lubricating oils, to develop improved techniques of rapidly determining undesirable mechanical conditions in diesel engines during periodic inspections of locomotives. This research will aid in avoiding catastrophic failures, premature wear, road failures and resultant delay of shipments and will substantially reduce maintenance costs on the locomotive fleet.

TITLES OF PAPERS PRESENTED AND INTERNAL FORMAL REPORTS ISSUED DURING THE PERIOD:

"The Development of Special Protective Coating Systems for Modern Railway Equipment", B.R. Potts and W.J. Fraser - paper presented at the 50th Annual Conference of the Chemical Institute of Canada, Toronto, June 7, 1967.

"Infrared Quantitative Analysis of O-Phthalic Anhydride Content of Unmodified Alkyd Resin Paints", C. Salama and R. Dunn - Canadian Spectroscopy, Volume 12, Number 5, November 1967, p. 178.

"Investigation of Compatability of Conventional and Semi-Ashless Oils with Respect to Engine Wear", D.R. Jackson, Physicist, C.N.R., in conjunction with H.U. Wisniowski, N.R.C., Mechanical Engineering Division, Report ME-223, August 1967.

"Investigation of Semi-Ashless Lubricating Oils and Additives to Diesel Fuel and Lubricating Oil", D. R. Jackson, Physicist, C.N.R., in conjunction with H. U. Wisniowski, N.R.C., Mechanical Engineering Division, Report ME-221, March 1967.

"Prevention of Water Pollution from Railway Facilities".

"A Spectrographic Sampling Method for Quick Assessment of Cylinder and Piston Ring Wear", D. R. Jackson and N. U. Wisniowski - ASME Paper 67-RR-5, May 1967.

"Evolution of Spectroscopic Techniques with Respect to Used Lubricating Oils", D. R. Jackson, Spectroscopy Society of Canada, November 1967.

NAMES AND QUALIFICATIONS
OF KEY R&D PERSONNEL:

T. J. Delaney,	B.Sc. (University of Manitoba)
B. R. Potts,	B.Sc. (McMaster University)
D. R. Jackson,	B.A.Sc. (University of Toronto)
M. J. Boulard,	B.A., B.Sc. (University of Montreal)
R. A. Fraser	B.Sc. (Mount Allison)
J. D. Dunn,	B.Sc. (McGill University)
A. Grant,	B.Sc. (University of Latvia)
J. A. Huns (Mrs.)	B.Sc. (McGill University)
K. O. Ludwig,	Diploma Chemistry (Freidrich Albert University, Germany)
P. Paley,	B.Sc. (Sir George Williams University)
C. Salama,	B.Sc. (Honours) (U.B.C.)
L. Veldi,	B.Sc., M.Sc. (University of Lund - Sweden)

SOURCE OF FUNDS:

In House and IRDIA Grant.

DESCRIPTION OF RESEARCH AND DEVELOPMENT PROGRAM

TITLE: Soils Research

OBJECTIVE: To advance the knowledge of soils mechanics as it relates to the industry to achieve the desired properties and performance of railway roadbed structures, to withstand the conditions imposed by the demand for more efficient transportation through higher speeds at greater loads and to reduce the cost of maintaining railway right of way.

METHOD: By performance deficiency research and soils mechanics studies of railway roadbed and track structures and by obtaining a fundamental understanding of the performance of the roadbed as a dynamic system.

PROGRESS TO DATE:

Extensive new line construction, particularly in Northern Canada has accentuated the need for a variety of soils mechanics projects. Studies on the relationship between ballast and subgrade for all track conditions to facilitate the design of track support are continuing. The effect of varying types of ballast, its thickness and density on distribution of load to the sub-grade and techniques for evaluating the heaving characteristics of the sub-grade in situ are continuing and are most important parts of this research.

Progress is being made in extensive research under way to develop methods of reducing the first heaving of track and associated heavy expenditures incurred by this condition. This research involves the determination of the optimum application of existing knowledge in establishing the benefits of physical vs chemical methods of track treatment.

A study of the causes and means of reducing erosion of slopes on railway right of way is continuing.

The above programs have important implications not only in reducing the cost of maintaining railway right of way but also for airport and highway construction and maintenance.

TITLES OF INTERNAL FORMAL REPORTS ISSUED DURING THE PERIOD:

"Research on Track Support - Measurement of Tie Deflections",
"Salt Treatment to Reduce Shimming on the Kingston Subdivision",
"A Test to Determine the Effect of Granular Sodium Chloride on Track Circuitry".

NAMES AND QUALIFICATIONS OF KEY R&D PERSONNEL

L. D. Baikie, B.Eng. (Civil), M.Eng. (Civil), Ph.D. (Civil)
Nova Scotia Technical College
C. J. Dalton, Special Training in Soils Mechanics (England).

SOURCE OF FUNDS:

In House and IRDIA Grant.

DESCRIPTION OF RESEARCH AND DEVELOPMENT PROGRAM

TITLE: Engineering Research

OBJECTIVE: To carry out basic and applied engineering research in virtually all of the engineering disciplines to meet the needs of an efficient transportation system and to develop designs, systems and hardware to withstand the rigorous environment imposed by Canadian operating conditions, increasing speeds and heavier loadings and to meet the continually changing needs of industry and of a modern transportation system.

METHOD: By carrying out basic, applied and design research studies in the fields of electronic, electrical, mechanical, chemical and civil engineering to meet the needs of the Company.

PROGRESS TO DATE:

Studies are continuing associated with the ride characteristics of freight equipment including fundamental studies associated with suspension systems, vibration damping and snubbing devices on freight car trucks. These studies, required as a result of higher loadings and increased speed of freight equipment, involve also the development and application of new measurement systems and advanced computer techniques. These continuing studies will ultimately provide new suspension systems and/or car trucks required for a modern rail transportation system.

Studies are continuing on the ride characteristics of passenger car equipment including the application of the environmental sciences to the ride of this equipment and the development of new and advanced techniques of measurement and assessment of passenger car ride. These studies are associated with present and future high speed ground transportation systems such as the new turbine powered trains.

Fundamental studies are continuing associated with the dynamics of train action when operating on line or in automated freight classification yards including the characteristics of cushioning devices and other draft gear which are being applied to improve and protect the transportation of goods.

Extensive research into improved means of measuring the speeds of diesel locomotives is continuing and has resulted in the development, to date, of very accurate and reliable analog and digital speedometers. Patents have been applied for on the devices developed to date and the rights to manufacture these devices on a world-wide basis have been assigned to a Canadian Company.

A basic research study of the nature of wheel slip on diesel locomotives, which results in serious loss of tractive effort and costly damage to wheels, rail and electric traction motors, has resulted in the development of a very accurate and reliable wheel slip detector for which patents are being sought. Research into the application of this device, together with a positive traction control system to automatically control wheel slip and thereby allow the locomotive to operate always at its maximum tractive effort, is continuing.

Research into the basic techniques for the determination of stress in components of track are continuing with the view to assessing and improving the performance of track as a dynamic system.

Extensive basic research into weighing of Railway cars in motion has resulted in the development of very accurate electronic scales, which have been patented and licensed to a Canadian firm for manufacture and sale on a world-wide basis. Additional forms and modifications of these scales are under continuing development and are in the process of, or will be, patented and licensed.

Research into the requirements for the protection of perishable products in transit has led to the development of new insulation systems and cars, container and highway vehicle designs for transporting these products. A new mechanically refrigerated car has been developed and an experimental unit designed and constructed which is now undergoing service evaluation. Research into insulation requirements for heated equipment is underway. The experimental car will continue to be used for research into improved mechanical refrigeration equipment, into the application of cryogenic refrigerants and absorption systems, into new and insulation systems and into the application of controlled atmospheres for the preservation of perishable products.

Development of an electronic system to provide improved performance of the electronically controlled humping operations in CN automatic yards is continuing. This system will reduce the incidence of overspeed impacts on cars with resulting reduction in damage to ladings. A patent application on this development is in progress.

Research into the requirements for new designs of freight equipment, multi-purpose cars, insulated and refrigerated equipment, cars for unit trains and containers, etc. is being progressed.

Research into measuring techniques and the development of a track recorder car to measure such track parameters as alighment, gauge, cross-level and surface roughness is continuing to facilitate the maintenance of track on the basis of scientific standards for track condition and thereby reduce track maintenance costs.

Research is underway on improving and expanding the methods and techniques for automatic testing of locomotives to avoid catastrophic failures, premature wear, road failures and resultant delay of shipments en route. This research will substantially reduce maintenance costs on the locomotive fleet. The studies involve improvements to existing methods and the development of new techniques for surveillance of the electrical systems on locomotives and the extension of automatic computerized testing of various mechanical functions of the diesel engines and involves the design of specialized transducers and circuitry for this purpose.

TITLES OF PAPERS PRESENTED AND INTERNAL FORMAL REPORTS ISSUED DURING THE PERIOD:

"Evaluation of Freight Car Cushioning Devices Through Simulation of Track Dynamics", J. T. Wilson and J. Thivierge - ASME Paper 67WA1RR-3, August 1967.

"Canadian Army Vehicle Impact Tests" - Research Report on U. S. Army Articulated Carrier XM 571.

"A Study of the Vibration at Low Speeds of 100-Ton Hopper Cars", July 1967.

"Vibration of 100-Ton Hopper Cars - Analysis of Results", October 1967.

"Road Test Data, "Barber Oleo" Draft Gears (Three Unit) Linton Subdivision", November 1967.

"Test of Vexilar Impact Recorders", April 1967.
"Investigation of Ride Characteristics of "633,000 Series" Container Cars", July 1967.

"Railway Refrigeration Research" - series of 15 reports on investigations of capacities of CN refrigerated vehicles.

NAMES AND QUALIFICATIONS
OF KEY R&D PERSONNEL:

J. Thivierge,	B.Sc. (Civil Engr.)(Laval University)
G.R. Cass,	B.Sc., M.Sc.(Elect.Engr.) (University of New Brunswick) D.I.C., Ph.D. (University of London, England)
K.A. Henderson,	B.Sc.(Mech.Engr.)(McGill University) D.I.C.(Imperial College, London,England)
F.J. Scott,	B.Sc., M.Sc.(Structural Engr.) (Queen's University)
J.T. Wilson,	B.Sc.(Mech.Engr.) (Queen's University)
J.G. Lamont,	B.Sc.(Mech.Engr.) (McGill University)
C.L. St. Louis,	B.Sc.(Electronic Engr.) (Ecole Polytechnique)
R.A. Kalita,	B.Sc.(Elect. Engr.) (University of Alberta)
A. Charenko,	B.Sc.(Mech.Engr.) (University of Manitoba)
P.P. Berthiaume,	B.Sc.(Elect.Engr.) (Ecole Polytechnique)
N. Begin,	B.Sc.(Mech.Engr.) (Laval University)
D.I. Yeudall,	B.Sc.(Sir George Williams University)
P.P. Marcotte,	B.Sc.(Mech.Engr.) (Ecole Polytechnique)
W.J. Scott,	B.Sc.(Elect.Engr.) (McGill University)

SOURCE OF FUNDS:

In House and IRDIA grant.

CASE HISTORIES OF COMPLETED PROJECTS

1. Research into the weighing of railway cars in motion has resulted in the development of very accurate electronic scales, which have been patented and licensed to a Canadian firm for manufacture and sale on a world-wide basis. The application of the new weighing technology has resulted in very substantial economies in Railway operations which has had a direct bearing on costs of transportation.

2. Research into measuring techniques and development of a track recorder car to measure track parameters in facilitating the maintenance of track on the basis of scientific standards and thereby reducing track maintenance costs.

3. Programs for protective coating development and application have been successfully carried out for a wide variety of Railway and other applications. CN has led and is continuing to lead in industry in Canada in the economic application of protective coatings.

EXHIBIT 2 F - OPERATIONAL RESEARCH

Major Projects 1962-1967

(a) Application of digital computers to simulate railroad operations - This covers a wide range of computer simulations covering various aspects of CN operations.

(b) Freight Car Distribution - Involved is a very large number of individual projects designed to improve the distribution of freight cars.

(c) Management Information Studies - This again covers a wide range of individual projects aimed at providing better information to management for control and decision-making.

(d) Application of CPM Techniques - Since 1964 most major projects in the company have been controlled using CPM. A list of current projects is shown in Section 2.7 (3). Other major projects have been the Saskatoon Redevelopment Project, the Toronto Commuter Services GO TRAIN and the CN EXPO Pavilion.

(e) Implementation of an Inventory Control system in CN stores based on modern statistical procedures for controlling the size of inventories.

(f) Development of improved car control systems - included in this have been a large number of individual projects covering various aspects of car control in industrial yards and terminals and over-the-road.

Case Histories of Completed Projects

1. Computer Simulation of Railroad Operations.

Digital computers have been extensively used to simulate various aspects of CN operations. Some of the more successful and useful simulations have been -

(a) Train Performance Calculator - This uses simulation techniques to calculate the minimum running time of any given train on any given section of CN track taking account of grade, curvature and speed limits, as well as the detailed characteristics of the diesel units and cars in the train. The computer can perform the calculations at a rate of 20,000 train miles per hour with much greater accuracy than is possible by manual methods. The TPC is now the basis for determining train schedules and to examine the effect of such things as varying the number of diesel units and the number of cars on any train. The net result has been more realistic train scheduling and more effective use of diesel power. In addition there have been many subsidiary benefits.

(b) Single Track Capacity Analyzer - This simulates the two-way Operation of trains on a single track line under centralized traffic control. The program moves the trains, arranges meets and passes and simulates the decision-making processes of the train dispatcher. The program is the basis by which all new proposals for capital expenditures in signalling and siding extensions are examined.

(c) SIMTRAC - This is a greatly enlarged version of the STCA. SIMTRAC takes advantage of the increase in computer size and advances in simulation programming languages to handle stretches of line up to 1200 miles (e.g. Toronto to Winnipeg, Winnipeg to Edmonton). It allows the railroad to look at long stretches of line as a whole instead of examining each subdivision separately.

(d) Under development is a simulation model of a railroad network which will provide a measure of origin to destination service and the congestion in yards and on the line which results from any given pattern of train schedules, train connection policies, yard resources and demand for transportation service. It will allow the railroad to examine the effect of changes in facilities and traffic volume on door-to-door service and will be an extremely useful aid to transportation planners both for planning capital expenditures for plant and for transportation operations planning.

2. Development and Application of CPM Techniques

CPM was introduced into the Company in early 1963 and its use has expanded rapidly since then. It is now used in all major projects including those involving systems and research studies as well as the more common construction and development projects.

CPM in the CN has evolved as a comprehensive and integrated package, comprising -

(a) Development of appropriate computer programs. When the CPM program began, the standard library programs available from computer manufacturers were not very suitable for CN purposes and a set of computer programs was developed internally. These were more efficient and easier to use than the standard ones, particularly for project updates.

(b) An intensive training program in CPM methodology and application. To date some 1800 CN project engineers and their staff have been trained to use CPM techniques.

(c) Maintenance of a small central group specialized in CPM techniques. This group provides back-up and consulting services to project engineers trained under (b) and is also responsible for further development of CPM techniquest and research. Presently effort is concentrated on CPM cost techniques and resource allocation.

As an example of the use of these techniques, one major project involving about $7½ million was completed in nearly two years less than originally planned with almost no crises, no unforeseen bottlenecks, and with net savings of over $3/4 million.

3. Car Distribution Project

The objective of this project was to improve the methods by which freight cars are distributed, and thereby the utilization of freight cars. Serious problems arise because of imbalances between the number and type of cars available for loading and the number and type required. Car distribution and utilization impinge on every aspect of transportation operations, and cannot be tackled in entirety as an isolated problem.

Various aspects of the problem have been tackled at different times and a wide variety of techniques has been used including allocation and inventory models, linear programming and queueing theory. Out of these have come improvements in organization, information and procedures necessary for better control.

Some of the more significant developments have been -

(a) Control of specialized cars - Studies and experiments demonstrated that both better service to customers and increased car utilization could be achieved by restricting the commodities loaded in cars and by the automatic direction of their empty movements. The development of the "yellow door" program for control of newsprint cars was so successful that the procedures have now been applied to other types of specialized cars.

(b) Control of bulk movements of cars - This entailed design of an improved information system, establishment of standards for car requirements and development of an organization system to match car requirements against car availability. The problem of car distribution for seasonal bulk movements is particularly severe, and creates complex car logistic and inventory control situations. The system is at present operating on a manual basis but is in process of being computerized.

4. Management Information Studies

The information system in the company for the control of traffic movements - Traffic Master Plan - was designed with active participation by Research & Development in the planning and design stages. It has been constantly upgraded to take advantage of developments in computer and communications technology.

With the advent of third generation computers and corresponding developments in communications, an intensive study was begun to design a management information and control system tailored to the company's requirements. In addition to the design and implementation of the computer complex, the study has included the development of systems to use the information for planning, decision-making and quality control. All phases of the project have been CPM'd.

The project is still proceeding and complete implementation will take another three to five years but many of the control elements have been designed and tested or are in course of implementation. Included is a terminal control system which is in process of implementation on a system-wide basis, a quality control system now installed in major hump yards and a means of deriving origin-to-destination trips in accordance with established standards for car moves and service requirements. A pilot test of an on-line real-time control system will begin in Montreal terminal area in early 1969. The system gives hope of a major advance in management information and control.

EXHIBIT 2 F - INDUSTRIAL ENGINEERING

Major Projects 1962-1967

1. Computerized Name Record System for Coach and Parlor Car Reservations at Toronto and Montreal.
2. Facility and Materials Handling Requirements for Customer and Catering Services for Turbo and Tempo trains at Toronto and Montreal.
3. Computerized System for production of Passenger Train Statistics.
4. Maintenance Improvement and Cost Reduction Study at Point St. Charles Coach Yard.
5. Preventive Maintenance of Passenger Cars based on Mileage.
6. Pick-up and Delivery Control System for Bonaventure Express Terminal in Montreal.
7. Layout of Cafe Lounge and Club Diner Meal Service Cars.
8. Disposable Air Conditioning Filters for Passenger Cars to replace washable oil soaked filters.
9. Use of Composition Brake Shoes for Passenger Cars.

Case Histories of Completed Projects

1. Computerized Name Record System for Coach and Parlor Car Reservations at Toronto and Montreal

The introduction on February 1, 1967 of the System-wide Electronic Reservation System for Coach and Parlor Car Passengers had produced in large centres at Montreal and Toronto a major clerical problem of maintaining suitable records of names of people who have made reservations, their option date for collecting the reservations, and details on reservation space. The system required additions and deletions of names as reservations were made and picked up, and searching of the files for expired options. Access to the information was required by up to 15 reservations clerks at one time.

A system to overcome this problem using a 1401 or 360 IBM computer for only 35 minutes each day was designed and installed in Toronto and Montreal. New reservations are keypunched during the day and processed at night. Reports are produced of alphabetical listings of names of people who have outstanding reservations, reservations whose option has expired and reservations whose options expire on the day of travel. Besides saving in clerical work, the computer name record system has enabled reservations not picked up when option time has expired to be quickly returned to the inventory space available on the electronic reservation system.

2. Facility and Material Handling Requirements for Customer and Catering Services for Turbo and Tempo Trains at Toronto and Montreal

Turbo and Tempo Trains were designed to provide a new type of meal service similar to that supplied to passengers on aircraft. Meals for club passengers were to be preheated in an oven and served on a tray at the passenger's seat. Coach passengers would buy their meals at a buffet counter and would be required to carry them back to their seats where a small table was provided.

Methods, facilities and equipment were designed for handling carriers with food, beverages and other items from the caterers and suppliers to the Turbo and Tempotrains. The facilities were designed for eventual expansion to include the operations required for the passenger long distance trains which were also undergoing a change. The Turbo and Tempo trains had to be stripped and reloaded in less than 30 minutes which meant this work had to be carefully planned and co-ordinated with other servicing as cleaning and mechanical inspection which was being done at the same time.

3. Maintenance Improvement and Cost Reduction Study at Point St. Charles Coach Yard.

This project included the development of engineered time standards based on MTM (Methods Time Measurement) and USD (Universal Standard Data) and using the standards to plan the work and measure the productivity of craftsmen. The project involved 12 analysts and one industrial engineer for 15 months for developing standards and installing necessary procedures. A complete reorganization of the operation was made as a result of this study which considerably increased the productivity of workers. Budgets and long-range planning now are based on standards that were developed.

EXHIBIT 2 F - DEVELOPMENT PLANNING

ECONOMIC RESEARCH

Economic research is almost exclusively the domain of the Development Planning Branch. The economic research undertaken by that branch falls within the areas of macro-economic research, corporate planning research, research into new technologies and costing research.

Economic research in the area of macro-economics is undertaken by the Company to support the broad function of corporate revenue forecasting. Dealing primarily with the industrial demand sectors of the economy, the output from the General Economist's staff is utilized primarily as input to the Freight Sales Department's revenue forecasts. The output from this group, in addition, is used to underlie long-range studies within the corporate planning realm. These latter studies are primarily dealing with the whole question of corporate acquisition or divestment.

The second area in which economic research is undertaken is in the area of economic analysis of new transportation technologies, such as solids pipelines and hovercraft, etc. These studies attempt to provide the Company with insight into the economic competitiveness of new technologies, vis-a-vis existing modes, primarily from the point of view of initial competition, but also from the point of view of possible acquisition and introduction of the new techniques.

The third area of Economic Research undertaken by this branch is in the field of costing research. This area of economic research underlies the Company's costing procedures which are employed for carload freight pricing and a whole series of contribution analysis in the carload freight, passenger and express sectors.

First Session—Twenty-eighth Parliament

1968

THE SENATE OF CANADA

PROCEEDINGS OF THE SPECIAL COMMITTEE ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*

The Honourable DONALD CAMERON, *Vice-Chairman*

No. 20

THURSDAY, DECEMBER 19th, 1968

WITNESS:

Canadian Transport Commission: R. R. Cope, Commissioner, Research Division.

APPENDIX:

21.—Brief submitted by the Canadian Transport Commission.

The Queen's Printer, Ottawa, 1969

29619—1

MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird	Hays	O'Leary (*Carleton*)
Belisle	Kinnear	Phillips (*Prince*)
Bourget	Lamontagne	Robichaud
Cameron	Lang	Sullivan
Desruisseaux	Leonard	Thompson
Grosart	MacKenzie	Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

29619—1½

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER
Clerk of the Senate.

MINUTES OF PROCEEDINGS

THURSDAY, December 19th, 1968.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 3.30 p.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Cameron, Grosart, Hays, Kinnear, Leonard and Robichaud. (7)

In attendance: Philip Pocock, Director of Research (Physical Science).

The following witness was heard:

CANADIAN TRANSPORT COMMISSION:

R. R. Cope, Commissioner, Research Division.
(*A curriculum vitae of the witness follows these Minutes.*)

The following is printed as Appendix No. 21: Brief submitted by the Canadian Transport Commission.

At 5.30 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Cope R. R. Raymond R. Cope was appointed a member of the Canadian Transport Commission on February 15, 1968. Born in New Westminster, B.C. on August 21, 1930, Mr. Cope took his public and high school education at various schools in the lower mainland area of British Columbia. In 1948, he entered the University of British Columbia on a Vancouver Sun Scholarship and graduated some five years later in 1953 with a Bachelor of Applied Science degree in mechanical engineering. That same year, Mr. Cope joined the Canadian National Railways in the Research and Development Department. In 1954, he was appointed Assistant Supervisory Engineer for C.N. Hotels and he became Supervisory Engineer there some two years later. In 1960, Mr. Cope returned to the Research and Development Department of the Canadian National where he occupied different posts in the research and planning area and was appointed Planning Co-ordinator for the Company in 1961. In 1964, Mr. Cope moved to the Department of Transport on loan from the C.N.R. and occupied the post of Director of the Railway and Highway Branch of the Department. In 1966, Mr. Cope accepted permanent employment with the Department of Transport as Director, Transportation Policy and Research Branch. During the early 1960's, Mr. Cope studied economics to the post-graduate level at Sir George Williams University and McGill University. Mr. Cope's present duties as a Commissioner in the Canadian Transport Commission are to organize and direct the development of the facilities and programme of research within the broad field of transportation in Canada. Mr. Cope is vice-president of public relations for the Transportation Research Forum, a past president of the Canadian Transportation Research Forum, and a member of the Engineering Institute of Canada. He is married and has three children.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Thursday, December 19, 1968

The Special Committee on Science Policy met this day at 3.30 p.m.

Senator Maurice Lamontagne (Chairman) in the Chair.

The Chairman: Honourable Senators, I learned this morning that Mr. Pickersgill was sick in bed and could not come this afternoon to answer our questions.

I think it would have been undesirable to postpone this meeting, because our schedule of inquiry after the Christmas holiday is a very heavy one and it would have been difficult to fit in the representatives of the Canadian Transport Commission.

Mr. R.R. Cope, the Commissioner in charge of the Research Division, has agreed to appear before us this afternoon.

We are very grateful to you, Mr. Cope. I assume that you will make an opening statement, and then we will have a discussion period. Before I ask you to say these few words, I would like on behaif of the Committee to tell Mr. Pickersgill that we hope he will return to work in perfect condition and continue to be as active as he has been over the years.

Senator Grosart: That is saying a lot.

Mr. R. R. Cope, Commissioner, Research Division, Canadian Transport Commission: Mr. Chairman, honourable senators, I will certainly be glad to convey your words of sympathy to Mr. Pickersgill. I hope that he will be up and around next week and that we will get back to some of the important things we have to deal with in the Commission.

I regret that Mr. Pickersgill cannot be here to lead the presentation of the Canadian Transport Commission to this Committee on the important subject of Science Policy, but because of his illness I a mafraid that will not be possible. I am, therefore, pleased to represent the Canadian Transport Commission.

The Canadian Transport Commission is a relatively new agency of government, having come into being only a year ago this past September. In view of our short history, we have not been able to develop any mature view as to what the over-all science policy in Canada should be, and the submission which we have made concentrates on the importance which the Commission attaches to research, our objectives in this area and our basic plans for meeting these objectives.

Now, the Science Council of Canada ,in its Report No. 4, entitled "Towards as National Science Policy for Canada," has made the following comments on transportation, and I quote:

> Today transportation research is fragmented. While different groups are involved in the development of specific pieces of hardware, few if any are looking at Canada's total needs.
>
> A co-ordinated major program on transporattion would aim at developing a ratiinal, national system. Setting up such a system would involve consideration of all of the necessary subsystems, of the inter-faces between sub-systems; for example, what is the best way of linking an interurban passenger airline service with an efficient urban transportation system? and would consider specific hardware development where the demands of the Canadian situation indicate that such is needed.

We agree that this has been the situation in Canada and regrettably so. Parliament, of course, has recognized this problem, we submit, and has outlined in Section 15 of the National Transportation Act a broad and fundamental range of research responsibilities for the Canadian Transport Commission in

this area. The challenge, of course, is very great, but one which the Commission gladly accepts.

The Commission has already adopted a substantial program of research which is outlined in Exhibit 3 attached to our brief, and will be adding to that program from time to time. The highest priorities in our program have been accorded to those projects which are concerned with developing a rational, national system of transportation.

To begin with, we feel that a necessary starting point in our research program is to develop a good understanding of our present transportation system. We are beginning to develop economic models of our transportation system and its sub-systems. We are taking a close look at the statistics and information systems, which today exist in the transportation area, with the objective of upgrading and mechanizing such systems to present-day requirements. Research into the costs of all systems of transportation and into the techniques for forecasting transportation demand are fundamental to the over-all program and will receive much attention during the early stages of our program.

Forecasting also implies a knowledge and understanding of changes in transportation technology and how this will affect the allocation of transportation demand. We therefore intend to initiate a series of studies concerned with evaluating the impact of specific new transport technology, such as solids pipelines, hovercraft, containerization, air cushion train operations, supersonic air transport, and new forms of urban transportation systems such as the teletrans system, STARRcars, automated jitney services, skybus, and other proposals of that type. It is entirely likely that we will move beyond the paper stage here, and a few years from now you will be able to look at such things as a solids pipe-line research laboratory, a high-speed rail research facility, or a test section of an urban transportation system from out of tomorrow. Even now we are discussing with the National Research Council the question of research on air cushion trains.

The research emphasis of the Canadian Transport Commission will quite naturally be directed not so much to the short-or intermediate-range problems, as to the longer range transportation requirements of tomorrow and how we can help to ensure that transportation systems develop as they must to meet future needs.

As is indicated in our brief, the CTC intends to use a combination of resources in carrying out the research program. In addition to staff within the Commission, part of the program might be undertaken by personnel in other departments or agencies of government, by consultants, or by universities either as part of their academic program or as part of specially contracted programs.

The CTC considers that one of its major goals in this area is to encourage universities to develop their capacities for transportation education and research. In general, up until very recently, Canadian universities have paid little attention to transportation, with the result that today there is a marked shortage of senior professional talent in this field in Canada, to the detriment of universities, industry and government.

The question of priorities, of course, is of much interest, and I should like to point out to the Committee that the Commission is greatly assisted in this area by an Advisory Council on Research, a 15-man consultative body which meets with us quarterly to consider progress with respect to projects already approved and included in the program and to consider possible new projects.

That completes my opening statement, Mr. Chairman; I will be pleased to answer questions with respect to this statement or to the brief.

The Chairman: Before I ask Senator Grosart to initiate the discussion, would you have with you the names of the members of the Advisory Committee?

Mr. Cope: Yes, I have a copy of the list of names right here.

The Chairman: Do you think it might be a good thing to have these names on the record?

Senator Grosart: Well, if you read them now Mr. Chairman, I think it might colour our discussion.

Mr. Cope: In alphabetical order they include Dr. D.E. Armstrong of the Financial Research Institute of McGill; Professor F.W. Anderson of the University of Saskatchewan, Regina Campus; Dr. C. L. Barber of the University of Manitoba; Mr. Fern Dooucet, Vice-President, Industry of Cape Breton Development Corporation; Mr. John Eyre, Saguenay Shipping; Mr. Jean Granger, Ecole Polytechnique; Professor Trevor Heaver of the University of British Columbia; Dr. Tillo Kuhn of

York University; Mr. E.H. Laborde, President, Laborde Petroleum; Monsieur Jean-Claude Lessard, President, Quebec-Hydro; Mr. E. Moncrieff, Standard Aero Engines, Winnipeg; W. J. Rae, Manager, Transportation Supply, Lever Brothers Limited; Madame Livia Thur, University of Montreal; Mrs. Graham Spry, University of Ottawa; and Professor A.M. Stevens of the University of New Brunswick.

The Chairman: Thank you very much; I think this would be useful for our discussion.

Senator Grosart: Mr. Chairman, I would first of all like to associate myself with your remarks about the regrettability of the absence of Mr. Pickersgill and say we hope he will be up and around to partake of the Christmas cheer with the rest of us.

We welcome you, Mr. Cope, particularly in view of the very important responsibilities you have undertaken as outlined in Section 7 of the Act. Perhaps I should read it into the record, for it is short. It is Section 7(4):

> One of the vice-presidents shall, under the general directions of the Commission be charged with the superintendence of the programs of study and research necessary to achieve the objectives mentioned in section 1 and to the performance by the Commission of its duties under section 15.

I may have a reference later to Section 15. In looking over the background of the Commission, particularly of the Research Department which I presume we can call it, I have noted that there has been very little discussion of the research aspect of the Commission's work.

It so happens that it is just two years to the day that Mr. Pickersgill started to guide the Act through the Committee of the Whole in the other place, and in discussions that covered some hundreds of pages of *Hansard* there is hardly a mention of the research function. The same thing applies pretty well to Mr. Pickersgill's appearance before the Commons Committee on Transport and Communications.

I suppose we can say this is understandable because politicians are perhaps more interested in the regulatory functions of the Commission than in the research. However, this seems to me to raise one fundamental question.

The Chairman: Do you define yourself as a non-politician?

Senator Grosart: I am a non-politician, yes, or an apolitician. This does raise the question, Mr. Cope, as to whether these two functions can be efficiently combined under one political entity. I am sure this question has occurred to you, and I would appreciate your comment on it. I am not asking for a policy comment, but rather a pragmatic comment.

The question that concerns me arises out of the tremendous importance of transportation technology research. Your brief makes it clear, and the evidence we have had from the Department of Transport and Canadian National Railways makes it abundantly clear, that the deficiency of the past that you speak of is a very serious matter, so that the necessity of an over-all research entity could not be more important to Canadian than it is today.

Now, I raise the doubt as to whether this over-all function which as your report says borders on the social, economic and other aspects of life, as to whether a responsibility so great can be discharged within one department of government. May a conflict not arise between your responsibility to advise the Commission and what some of us see as a responsibility for somebody to monitor the Commission, in other words to feed in transportation science input into government decision-making at a level above that of the Commission and even above any one ministry? Would you care comment on that possible conflict?

Mr. Cope: Yes. There are several kinds of answers I could give to that question, Senator Grosart. One answer that occurs to me is that this particular problem area is one that was carefully considered within the Department of Transport prior to submission of the bill to Parliament. Much attention was given to the strengths and weaknesses of this kind of approach.

We opted in favour of recommending to government that they proceed on a basis of setting up a two-headed commission, as it were, one to look after economic regulation and the other to be concerned with research on the basis that this seemed to be the best answer to the problems facing the country at the time.

The need for research and for continually updating our approaches to economic regulation and policy promotion in the transportation field was so great as to necessitate appropriate mechanics within the regulatory body.

We were, of course, very concerned with the problem of involvement or over-involvement of research personnel in the economic regulatory problem areas of the Commission, and vice versa, and have organized the Commission so as to minimize the problems that might follow in that respect. What we have tried to do in structuring the group is to make it possible to feed back to the research group sufficient understanding of the current problems so that the group does not become ivory towered in its approach, and is aware of current problems encountered in licensing of operations or in implementing new air policies, et cetera and, on the other hand, to have a source of expert personnel over a broad range of disciplines available to the Commission to deal with the complex problems they have on the other side.

Another answer I could give to this question would be that only time will tell. I think that ten years from now we can look back and reach some view as to whether or not the experiment has been successful. As a professional I think that it is an experiment, one that we think can be made to work, one that we are working hard to make work, but in the final instance it will be history that will record whether or not it has been successful.

I think that to have taken another approach and to have given to the Commission no basic research function might have left us with an institution that was too much like the past, too fragmented in its ability to deal with transportation systems, too much inclined to the modal approach, to the carrier side of things. With the research arm we tend to think in terms of transportation systems; we tend to think in terms of the transportation required by the users and the consumers of transportation. I think that had I to do it over again, to make recommendations, I would still advance this point of view.

Now, a third answer I might give to this question would be that it is my assumption that Parliament had considered the problems in these areas and had reached a similar verdict. The bill was considered in both houses and was passed. It received royal assent in February, 1967, and we look upon that as Parliament's instructions to us.

Senator Grosart: There is no doubt about the third point; on the other hand, we would be rather unduly restricted if we did not feel we had the right to look beyond the wisdom of Parliament in the past. I know you will see my concern. It arises, for example, out of reading the proceedings of the Commons Transport and Communications Committee where immediately Mr. Pickersgill appeared Newfoundland descended on him and practically the whole inquiry was about the railway situation in Newfoundland, which I assure you I am not going to ask you to comment on.

So that the concern that would be in my mind is as to whether the political controversy that could very well arise over the regulatory activities of the Commission might tend to detract from the effectiveness, the validity and the acceptance of the work of the Research Department.

For example, do you see that department as having the right to initiate studies?

The Chairman: Do you mean the Department of Transport, or the Research Division?

Senator Grosart: I am sorry; I should say the Research Department, to make it clear. I do not believe you have a name for it.

Mr. Cope: At the time we are referring to it as the Research Division of the Canadian Transport Commission.

Senator Grosart: Do you see the Research division initiating studies independently of the Commission in its other function, or do you see it as only making studies on a referral basis from the Commission or the Minister of Transport?

Mr. Cope: I can certainly report what the situation has been to now—that the research program outlined in our brief is largely the product of ideas developed within the Research Division and those developed within the Advisory Council on Research. I would say that the bulk of the program represents the thinking in these two areas, although there have been ideas referred to us from the other part of the Commission and from government as a whole.

We are receiving suggestions even now from other departments of government; I think we have something like 72 project proposals from departments of government that we will consider at our Advisory Council. We will go through this list and see how we can combine the research projects into perhaps broader research projects that might answer more than one person at the same time.

I think that we are going to get ahead very nicely. I have had certainly no problem in

advancing programs. The Newfoundland controversy had not affected our work in any way at all.

Senator Grosart: To move on to another subject, I have quite a number of questions but I will ask only a few of them as I know other members of the Committee have questions to ask. We are all very interested, of course, in all aspects of transportation, but one that has come up frequently is the automotive aspect. I know this is a cloudy area. Again I do not want to ask you to interpret legislation, but my understanding is that Part III of the Act has not been proclaimed.

Mr. Cope: That is correct.

Senator Grosart: Could I ask you then to just give us a capsule description of the federal authority, the federal jurisdiction that will be exercised by the Commission in this automotive field?

Mr. Cope: This, of course, has been considered by the highest authorities in the land. In 1954 the decision of the Privy Council ruled that the federal government had the responsibility and the authority to regulate a federal motor vehicle undertaking that dealt with interprovincial motor vehicle traffic. I think that the actual wording was that they will deal with extra-provincial undertakings in this particular area. You get into the complexities of the problem where a company is part of both, but by and large it divides into interprovincial motor vehicle traffic and intra-provincial motor vehicle traffic.

Senator Grosart: Again I do not want to get into a policy area, but I am thinking of your research function: Is the situation now that provincial bodies are acting as agents of the federal government in this area?

Mr. Cope: This has been my understanding and I must say this at the outset, that I am not a lawyer for the Commission and I really cannot interpret law but it has been by understanding that provincial boards have acted as federal agents.

The Chairman: They have delegated?

Mr. Cope: Yes.

Senator Grosart: Yes; they can delegate to an agent, but not to a provincial legislature. Have you any projects under way in this field in any way relating to the motor vehicle as a carrier?

Mr. Cope: I think a number of our projects deal with all forms of transportation. We are trying to look at transportation systems and decide what are the ground rules for determining whether a system is economic, efficient or adequate. We look at all forms of transportation, all combinations.

We think that if we are going to meet this kind of goal that we recognize no jurisdictional problem area, we research the whole.

Senator Grosart: This, of course, comes around to my original point, whether as a division of the Commission acting under a federal ministry you can justify doing research in this area? You mentioned, for example, in your opening remarks the very urgent problem of integrating the ground side of air transportation. Do you consider that you can go into this whole area as it affects motor vehicle transportation, or do you see a restriction in your relationship to a federal department?

Mr. Cope: Of course we would want to take a look at each particular project proposal as it came up but I think the over-all thinking would be that a national transportation system includes the whole of transportation in Canada.

In so far as our research goes, for example, in this review of national transportation statistics it would be silly of us to look at statistics in one area and not at statistics in another. What we are trying to do is produce a better understanding of our transportation system. I know of no practical problems that we have encountered in this area to this point in time.

The Chairman: I think the research activities by themselves have not been divided by the Constitution, so that it has always been considered by experts in this field that this is a joint responsibility. That is why there is a lot of research going on within the federal government related to fields which are under provincial jurisdiction.

Senator Grosart: There has been some objection to that, but I will not pursue it any farther. You say in your presentation, Mr. Cope, that you are not ready yet to spell out the relationship your division may develop with other government departments, and so on, but you do specifically mention, as you did in your opening remarks, the NRC. Would you expand a little on the kind of relationship? You have already mentioned, for example, that some departments have asked you to undertake studies.

Mr. Cope: Certainly in respect of the National Research Council we see them, as I say in the brief, as a kind of natural partner. We think that where physical research programs seem highly desirable and where it seems highly desirable to conduct them within the federal ambit that they are probably the group to undertake it. If we were going to build solids pipeline facilities in Ottawa, say, then I could not see much sense in our attempting to build them and put them in the basement of the ConGill Building, where we are located. It would make much greater sense to have the National Research Council develop these on their grounds on the Montreal Road.

We think that they can be a mechanical, physical arm for us; that we will be continually looking over and surveying the transportation field to reach views as to what transportation should be researched and when physical trials are called for we will look to them to carry them out for us.

The Chairman: Do you intend to have your own labs, for instance?

Mr. Cope: No sir; we think that this is a kind of thing, if labs are required and if it is required that they be within the federal group, that the National Research Council as of now is probably the group to house the laboratory facilities. On the other hand, we think it is quite compatible with our goals to work with universities or other institutes in the same way.

With respect to the other departments of the government, I think that each of the other departments of government have their own particular goals and programs and we are interested in designing our programs to assist them where there is some common interest in our programs. For example, the Department of Indian Affairs and Northern Development are, of course, always interested in transportation development in the north of Canada and we talk to each other from time to time about programs of research and the transportation in the north. I think that we have a common interest there; we are interested in the adequacy of transportation throughout Canada and they are interested in transportation, amongst other things, in the north of Canada. So I think that we have a common denominator there.

The Department of Transport, of course, is a natural ally for us; they have particular operating goals in Canada; they operate airports; they operate coast guard services; search and rescue; aids to navigation.

We will have times where there will be research programs that we will have a common interest in. I can cite one example right now: the hovercraft research. The Department of Transport has had an interest in this because they have gone and bought a British SRN 5 for the coast guard operations and they have put it into service in Vancouver. We have an interest in this as a possible new technology for application in Canada; the National Research Council has an interest in this; and Energy, Mines and Resources are interested in the possibility of using these vehicles for testing the water in the Great Lakes during the mid-winter when they are frozen over and they can run out on the ice and drill holes and see how polluted the water is at that time of year.

We have working relationships with a number of departments of government and these are evolving and becoming a little more solid as the days go on. I think that a year from now they will all be pretty clear. The area we have had to think about the most has been our relationship with the Department of Transport, because until the coming into being of the Canadian Transport Commission the department was looked to as a primary source of transportation policy advice and for research that fell in the transportation area that was not covered off in any other way.

We have been sorting out which area we should each become expert in and how we could get good feedback between us so that we do not miss research that should be undertaken and on the other hand we do not duplicate research work.

Senator Grosart: One final question before I stop, Mr. Chairman. I notice in looking through your estimates that the budget you might apply to research is very small at the moment. Have you made a projection of the kind of budget you see that might be necessary for your research division?

Mr. Cope: There again I have two answers for this question: We made an early five-year forecast that we gave to Treasury Board early in the year. I believe we put it together the first week that I was on the job, and it was fairly modest. I think that it showed our budget climbing to about $3 million in 1973.

Senator Grosart: From about half a million this year.

Mr. Cope: Yes, about half a million this year. During the months that I have been with the Canadian Transport Commission I have talked about transportation needs with the Science Secretariat, Dr. Solandt, with the Canadian National Railways, and anybody else who had a view on this subject. I have come to the view that I was very modest indeed. I think now that we should be aiming at a research program by that same year that might range as high as $15 million. Certainly if we become involved in demonstration projects of any kind we could spend money very quickly. I am beginning to think that some demonstration projects are pretty much in order, and that we shall probably do something in that area.

Senator Grosart: Have you put any tentative numbers against the program that you have outlined here?

Mr. Cope: This program?

Senator Grosart: Yes?

Mr. Cope: We are currently discussing contractual arrangements with consultants on a number of these and I think that only after we have completed this will we have a good view, but the program that we have outlined here would probably cost in the order of $5 million to $7 million.

The Chairman: No, but I thought that you were asking in terms of staff?

Senator Grosart: No, that is another question. The presentation discusses the adequate level or the efficiency level of staff, but I will leave that for a moment and let somebody else have a chance.

Senator Cameron: To begin with, I think it is a healthy sign that the Canadian Transport Commission has set up a research unit that has a very important role to play. I have one concern about it, however, and that is the possibility of this becoming an empire within the transportation organization. This is a natural tendency. I am not imputing motives or anything like that, but I think something has to be watched.

In the course of your remarks you mentioned that you should establish a solids pipeline system. I would assume that you would do this through the existing agencies. The Alberta Research Council has already as far as I know done most of the work in this. Would it be your thought that by grants, or by assistance, or by request, you might ask this to be the agency you would act for your Research Department in this particular field, or are you thinking that it would be necessary for you to set up something in addition?

Mr. Cope: Senator Cameron, I will say this: I admire very much the work that the Alberta Research Council has done in the area of research on solids pipelining in the capsules area. Of course, capsule pipelining is not the only method of moving solids through pipelines. You can use slurries; you can use cannon balls, slugs and paste. There are different techniques that you can utilize.

We have different pockets of interest in this in Canada. The University of Toronto has said that they have got a number of smart people down there that are doing some research work, graduate theses, and the like. They say that perhaps they are in a good position to advance some work on slurry pipelining.

We have not reached a final view on this; we are considering the various proposals. Again I have in mind the Alberta Research Council work on solids pipelining was funded through the DAIT programme. I have forgotten what the initials stand for, but it involved collaboration between government and industry and the province of Alberta. They have completed one phase of research on capsule pipelining. The evidence is being considered right now by the Department of Industry, who were the funding agency of the federal government in this area. The Department of Industry will be considering follow-up research in this particular area and I do not quite know what verdict they may reach but, of course, what verdict they do reach interests us in the Canadian Transport Commission very much, because I think that we cannot allow solids pipeline research to start and stop in Canada; there has to be some managed, funded, organized and co-ordinated kind of continuing program. How it should be we are not quite sure about.

The illustration I was using earlier was that I considered the National Research Council as a better place to do anything in a physical way than ourselves, but I did not mean to say that they would be our choice over the Alberta Research Council or the University of Toronto, or the University of Saskatchewan, who have also an interest in the area.

Senator Cameron: The Dominion Coal Board has done quite a bit of work in this area with regard to the slurry pipeline. I

attended a seminar for three days on this where they brought in some Belgians and French, who apparently have done more than anybody else in transporting coal in this way. The Alberta Research Council tied into that too.

The impression I came away with was that they had quite a few problems to solve before this could be done satisfactorily. I am just wondering what agencies there are in Canada presently competent to do that kind of study, or can we draw on the French and Belgian experience to save doing over again the work they have already done?

Mr. Cope: Of course it is always highly desirable that we do this, and I know that we have tried to tap into the work of SOGREAH in the past. We talked to the Czechoslovakians here a little earlier this year. The Americans, I feel, know as much about the movement of coal through slurry pipelines as anybody. They have had a 108-mile coal line in operation down in Cadiz, Ohio, and if I recall correctly they are even now building another long coal pipeline. The Research Institute at the Colorado School of Mines also has a great fund of knowledge in this area.

There are many combinations. What the right combination is we are not sure about right now, but we are considering it in conjunction with the Department of Industry, the National Research Council and the Department of Transport, and we hope that we will reach conclusions on the subject shortly.

Senator Cameron: As far as I have been able to gather, the American experiment on this 108-mile pipeline you referred to is probably as successful as any, even more so than the French.

Mr. Cope: Yes. I think that it was successful to the point where the railroads down there put in unit trains and took the business away from that coal line again, but I think that the economics are turned again in this new pipeline that is being built.

Senator Cameron: In that same area there is a school of thought which suggests that instead of shipping thousands and millions of tons of coal by freight trains, or shipping out through a pipeline, that it would be better to develop the gases in situ and pipe the gas away. I do not know what is being done in this country. I believe the Russians have done quite a bit of this, but here is something that would affect the railways and the pipelines and might put them all out of business.

Mr. Cope: Yes. There are a number of interesting interfaces between the transportation system and the energy systems that have to be considered.

Senator Cameron: In your budget, I agree that you are very modest in the sum that you have projected for 1973. One of the things I think that has impressed this Committee has been almost the total lack of any centralized research in transportation, which is one of our biggest industries, representing about 7 per cent of our GNP, so I think we welcome the establishment of the Canadian Transport Commission and their setting up a research arm. In looking through the proposed research program, a lot of this I think is quite in keeping with what you should be doing, that is studying the deep sea merchant marine commensurate with Canadian maritime needs; the general economic standards and criteria; the feasibility of developing certain transportation systems, whether it is economic, efficient, adequate, and so on; the development of techniques for forecasting, and all that sort of thing, but when you get into some of these things involving rather large laboratory establishments I am wondering if the direction should be to ask the National Research Council to do it, or to ask any one of a number of universities that might do it and they might have to be funded?

Mr. Cope: I think this is entirely sensible. I know that if Mr. Pickersgill were here he would argue very strongly in favour of that, that we are looking for ways to develop competence in universities. We cannot help but feel that there has been a big problem in this area and we are trying now to give the universities every opportunity to develop their interest in transportation, whether it be on the physical side, the economic side, or what have you.

I certainly do not feel that we should build any laboratories or any new test facilities within government unless it be through the National Research Council, but I think that we will use every occasion we can to locate them in universities.

We have also had several proposals of this kind. For example, I had the Dean of Engineering of Queens University approach me at one time about developing a railway research centre at Queens University. This appealed to me very much and I told him that if he was able to convince the Canadian National and the Canadian Pacific that it was a good idea

that he would find us easy marks in Ottawa for our part, but he has not made much success in the first area, I guess.

Senator Cameron: Another area I think that has impressed us is how little has been done in universities in this area though. Could you answer at the moment how many Canadian universities are doing work in the transportation field and, if so, in what areas of the transportation field?

Mr. Cope: I think it is all a matter of how much work they are doing; I think there are rather few doing substantial amounts of work; you can count them on a couple of hands.

The University of British Columbia in their Business and Commerce Faculties have a program of studies both at the undergraduate and graduate level in the economics of transportation, the business of transportation. The University of Manitoba has a developing program in roughly the same areas. In Ontario, Waterloo University has an extensive engineering program that deals in transportation engineering. These three universities stand out from all others in the amounts of work they do.

Now, I think that you will find that all the major universities have little bits ongoing; I think the University of McGill has had different people who have had an interest in transportation and have had something going at digerent points in time.

York University has shown some interest in developing a transportation research centre; they have not been sure that it should be necessarily located there. They suggested Ottawa as a first choice. The University of New Brunswick has a little interest in transportation but, by and large, there has not been very much work undertaken there. There has been an occasional staff member at other universities who have had a graduate student doing a little bit of work in the transportation area, but I think that the three universities I mentioned are the only ones that have anything on a large scale.

The Chairman: What saff have you at the present engaged in research?

Mr. Cope: At the present time there are ten people on the job, and six people are coming.

The Chairman: How many of those are Canadian born or Canadian trained?

Mr. Cope: Eight.

The Chairman: Out of how many?

Mr. Cope: Sixteen.

Senator Grosart: Trained to what level?

Mr. Cope: I would say that more than half of the people we have engaged have two degrees; some have received combination degrees in economics and engineering, some in economics and law.

The Chairman: And out of those eight, how many specialized in the United States, for instance, or elsewhere?

Mr. Cope: Two of the eight Canadians took post-graduate work in the United States.

Senator Grosart: Have we ever qualified anybody at the Ph.D. level strictly in transportation technology?

Mr. Cope: One gentlemen who is joining us, Richard Soberman of the University of Toronto, has taken a Ph.D. at the Massachusetts Institute of Technology. Now, you are asking if there is anybody who has taken their doctorate in transportation in Canada?

Senator Grosart: Yes?

Mr. Cope: I know of no one.

Senator Cameron: Is it correct that no Canadian university at the present time is offering either a diploma in transportation technology or a degree in it?

Mr. Cope: In transportation technology?

Senator Cameron: Or in transportation of any kind.

Mr. Cope: I think that the University of Waterloo's program now provides for doctoral students. I do not know that any students are following that program, but I think they can. The University of British Columbia's program certainly does not; they go to the master's level only. The University of Manitoba, I think it is their intention to go to the doctoral level but they are so new as to make it unwise at this time.

Senator Cameron: Some universities think they must keep up with the Joneses and they have the buckshot approach; they put in their calendar a whole raft of things that never materialize. This is why I am suspicious that this is the case with some of them.

Mr. Cope: We would welcome any opportunity to encourage universities to develop

their programs in an intelligent, mature way to the doctorate level.

Senator Grosart: Do you project a crash program to make up this almost unbelievable deficiency in scholarship in transportation technology? I mean a crash program; that is the phrase I used.

The Chairman: In universities.

Mr. Cope: I think that in recent years we have been trying to plant moneys in universities wherever we could to get them to develop programs but the problem is with the management of the moneys. There is a serious shortage of university staff with skills in this area. There are four or five good teachers in Canada and they can get jobs anywhere in Canada. This has been the problem—to find people that could lead the programs at the universities.

You could find a great number of students by providing fellowships and scholarships if you had someone to lead the research in the programs.

Senator Cameron: Does it not seem to you that you ought to be able to give some lead in this respect? For example, the Department of Aeronautical Engineering at the University of Toronto has a world reputation because it has staff in depth. The Montreal Neurological Institute is the same, because they have staff in depth. In our own province the petroleum engineering has staff in depth.

It seems to me that rather than getting a lot of universities involved in this we have got to be selective and say this one has the facilities, or a limited amount of facilities and if these are added to judiciously this will specialize in one area and another one in another area. We cannot have them all getting into it.

Mr. Cope: I agree with you fully on this point; perhaps I could reveal a little bit how our thinking has been developing. We felt for a long time that we have to have pockets of excellence or research centres in the universities and the problem comes up as to how many.

I know that at one time Mr. Darling and I went to a number of universities. We talked to them about their interest in transportation and all of the universities had no transportation program at all.

We got back to Ottawa and we received nice four- and five-page letters in which they would say well: "We have not been interested, but we are now. Will you give us a quarter of a million dollars to get us going?" We had quite innocently created a political problem with respect to which universities should receive our favour.

We opted as an interim plan to follow the idea that if a university got something going on its own, showed some initial momentum, we would give them some encouragement. The University of Manitoba fell into that category. Now we are inclined to think that perhaps we should have as an objective developing five pockets or five centres in Canada.

Senator Cameron: No more?

Mr. Cope: I do not think we can have very much less. We already have one at Manitoba, one at Waterloo that seems to have an interest, and one at British Columbia. There are two to come. This is a program that the Department of Transport and ourselves have worked up and we are hoping that it is going to be a sensible kind of program.

Senator Cameron: On that advisory list that you read out, how many of those were senior people at university level and people at the policy formulation level in the universities?

Mr. Cope: It is hard to pick and choose between them; I think that certainly, I know that Dr. Barber, who is head of the Department of Economics in Manitoba, would fall into that category.

Senator Cameron: He is vice-president of the university now.

Mr. Cope: Dr. Armstrong is certainly at policy level. I know that Tillo Kuhn has been very influential at York University. Professor Fred Anderson at the University of Saskatchewan is certainly a world recognized expert in the economics of transportation. I think we really picked, or developed a list of possible candidates that were leaders in the field overall. If I do not pick and choose between them, we have nine members of our 15-man council from universities.

Senator Cameron: Some of them are in economics though, and rightly so, too. But the point I want to emphasize is this, that it is important to get university personnel who are at the policy formulation level; you have them and I just wanted to underline that, because these people can be very helpful to you and you can be very helpful to them.

Mr. Cope: Yes, we have found this already.

Senator Hayes: I am wondering, Mr. Cope, in your program how much study you give to duplicate programs which you mentioned in your initial statement. How do you handle them in the areas of the United States, or Belgium, or some of these other countries who have quite a bit of expertise in so far as certain programs are concerned? How are we in Canada going to handle this problem of duplication?

You mentioned that your budget is $3 million, and then you say, well, I should have made it $15 million, without really any reason to make it $15 million other than you think you might be able to do a better job with certain programs. Do you have programs in mind?

Mr. Cope: Certainly as to mechanisms for drawing on the important research carried out in other countries I believe we are becoming familiar with more and more ways to do this. In the case of the United States we have developed a formal approach to them; we have already with the government, the Department of Transport, formal links with them and they have inventoried transportation research throughout the United States that we can draw through them and a knowledge of where transportation research work has been carried out.

We also get readings on transportation research work that is carried out in other nations through media such as the OECD and ECMT; also through, strictly bilateral arrangements with any nation. For example, with Czechoslovakia last year; the Czechoslovakians were interested in pipelines. We had become familiar with their interest in coal pipelines and we had to decide how we could work together so that we do not duplicate the research and can draw knowledge from one another in the most intelligent way.

I do not know that we have a fully developed matrix of approaches for this area, but we are developing better understandings as the years go by.

Senator Hays: Do you propose to do some research in so far as urban transportation is concerned, which is one of the great problems in transportation?

Mr. Cope: Yes, our view on urban transportation is that it is part of the transportation system of Canada and that if we are attempting to define what an adequate, efficient, economic transportation system is we cannot exclude it. What our specific initiatives should be in this area vis-a-vis other departments of federal government are under review. The Department of Transport has an interest in this area; Central Mortgage and Housing has an interest in this area; Mr. Hellyer's task force has been listening to a number of people put forward their views on urban living and transportation that might give us even further ideas.

I do not know that we have a fully coordinated approach in this area yet, nor can we sensibly until the report of this task force has come forward.

Senator Hays: I think of some of the countries that I have been in; it seems to me that in urban transportation probably the best that I have ever seen would be in Tokyo, for instance, where they move millions of people, and they do it in a great hurry. Trains are travelling at 140 and 150 miles an hour and they brag about a train leaving at 6.10 in 12 seconds, or something like this, and it does this sort of thing.

Then they have their overhead transportation; they do not have the automobile problem that we do, but they do move masses of people. Now they are getting ready to move them from Tokyo out to where they are going to hold the Olympic Games. When we were applying to have the Olympic Games in Canada we were really amateurs when it came to moving people.

How close will you be working with, say Japan, in this field of transportation?

Mr. Cope: Of course we have followed the Japanese development of rail technology both in the intercity and in the suburban service; we have some knowledge of that.

I really cannot answer you directly as to how closely we will work with the Japanese, if you mean we, the Canadian Transport Commission. If you refer to the federal government unit who will ultimately have prime responsibility in this area, however, I feel that they should work very closely with them. Of course, the transportation problems in Japan are of a different nature then in Canada. In Tokyo they have something like 11 million people; we do not have anything like that in Canada. We have the problem of moving $2\frac{1}{2}$ million people in Montreal, I guess, and two million people in Toronto.

Senator Hays: Would they not sort of laugh at us for the awkward way in which we do it?

Senator Grosart: They have gone broke and we have not.

Mr. Cope: I do not know what the political structure in Japan is, but I submit that we have to consider that we have different levels of government here that have different responsibilities in the area and what the federal role should be, I do not know that this has been fully researched or that there is an agreed upon consensus in the area. I recall, however, that at the Housing Conference a year ago the proposition was put to the premiers that perhaps the federal government should assume responsibility in transportation research in urban areas.

Whilst this was not fully debated it seemed to be accepted, so I think that this was taken as some encouragement to develop an interest in it in Ottawa and this we have done. What specific initiatives, what specific programs should be adopted in this area, are yet to be thought through. Another aspect of it, of course, is the financing; where the money is to come from for elaborate systems that will move people at the rate and speed that exists in Tokyo is an important one. How we resolve this I think has yet to be worked out.

Senator Kinnear: Mr. Chairman, yesterday we talked about many of these same subjects, so I will refrain from asking questions on them.

Particularly intercity travel, instead of all the glamour that we are attaching to the great rates of travel in Canada, if we could get accommodation for passengers at hours that they could be used I would be quite happy.

I wonder if you are only going to research into the very highly developed schemes and keep them on the main lines or are you ever going to get off the main lines and into some of the more heavily populated areas?

Senator Grosart: Particularly the Niagara Peninsula.

Senator Kinnear: Yes.

Mr. Cope: We had quite an interesting discussion on this point at the last meeting of our Advisory Council and we were considering what costs we take into account, what data we take into account in our analyses.

I take it that when we deal with inadequacy of a transportation system we have to think in terms of the point that you mentioned, whether the transportation is there at the time that people want to travel. I think that we not only want to take into account the enjoyment from and the quality of transportation, but also the impact of the transportation system on those who are not eager to use it but are affected by it should it happen to move by their door for one reason or another. Whilst our programs do not explicitly deal with this point, it is the kind of thing that we deal with in meeting our broad transportation goals.

Senator Kinnear: They all seem to be so far in the future. Here is another question I am interested in: It is the study of the differences between grain handling transportation techniques of the United States, Australia and Canada. This is one of our major businesses; what are your conclusions?

Mr. Cope: This project...

Senator Kinnear: Do not tell me it is not going to start or something.

Mr. Cope: Yes, I think I should say, that we have in recent days decided to broaden this particular study to be an over-all transportation system for grain including the movement of grain from the farm to the export point.

Perhaps I should say this, that in the area of grain transportation, this has been pretty close to the bone in Canada, that the farmers, the elevator operators, the railways, the government, the Board of Grain Commissioners, a lot of parties that had an interest in the transportation of grain, have looked at the transportation from different points of view. The railways have tried to move the grain at a minimum cost; the elevator operators have tried to see that the grain flowed in a way that would maximize their net return on an elevator operation; the Canadian Wheat Board has tried to move grain at times when they thought they could sell it and it was the most convenient way to meet the Wheat Board marketing objectives.

We have been trying for a long time to find a way in which the different parties could work together to what you might call optimize all of the policy objectives of different groups. Now, two years ago there came into being a grain transportation technical committee in Winnipeg that included representatives from the railways, the Wheat Board, the elevator operators, the co-ops, the Board of Grain Commissioners.

They have been working very diligently for two years now on promoting a more efficient

grain transportation system. They have worked on things that have no glamour, but are nonetheless important: on their order system; on their delivery arrangements; and spotting of boxcars. They have made important progress in this area. We think now that they have made good progress on the short term development aspects of grain transportation and it is time to look to what is perhaps longer term research to perhaps the kind of system that we should be working to, a system that will optimize your transportation of grain, at the same time meeting your marketing objective. This is a longer term research project, but it is one that we feel that the time is right to act on and one that will supersede the specific project that you will see on that list.

Senator Robichaud: Mr. Chairman, I am rather hesitant to ask my question, because it has to do again with duplication and questions on duplication are overlapping; they have been referred to by Senator Grosart, Senator Cameron and Senator Hays. So may I ask it just the same.

If we look at the organization of the Commission here, it is responsible to the Minister of Transport; on Exhibit 3 you have outlined 21 different projects or studies which have been approved by the Advisory Council on Research at their meeting in Ottawa on June 10th and 11th of this year. Now, if you read the list of those projects, Senator Cameron has outlined some of them, it appears to me that practically everyone of them is either looked into or being studied by the Department of Transport.

Now, you have mentioned that the Transport Commission is in very close relationship with DOT. In order to avoid any overlapping or duplication of efforts, is there not a possibility that the Commission could be assigned all the research for the department?

Mr. Cope: I think perhaps in respect to the program, if I can deal with that to begin with?

The Chairman: Or the opposite.

Senator Robichaud: Or the opposite, so that we do not have two similar agencies doing the same work within the same department.

Mr. Cope: To begin with, the program of research that you see listed here is a program of research that was formulated after consultation with the Advisory Council and at that meeting there were two representatives of the Department of Transport to look through the whole of the list to make sure that this did not match up.

Senator Robichaud: This is one way to avoid duplication that you have?

Mr. Cope: That is right; this is a formal way, whereby at the Advisory Council meetings they look at our research programs; we do the same with them.

I might say that fundamentally the problem is not perhaps so great. I think that there is agreement between the department and the Canadian Transport Commission that there are certain kinds of research that will only fall to one or the other. The inter-modal research, the longer term research are naturally the kind of research responsibilities of the Canadian Transport Commission. There are no misunderstandings on this point. The research that relates to the operating activities of the Department of Transport is clearly the kind of research work that the Department of Transport should attack; they are an operating department, they have some 17,000 people concerned with operating something. They are operating airports; they are operating meteorological services; they are operating coast guard systems; they are operating telecommunication systems. This is an operating department and they have specific operating responsibilities and they should and they do conduct research in respect to their operations.

So that I think that in over 90 per cer of the spectrum it is a fail safe kind of procedure—that we are not likely ever to duplicate research work in either area. I think that perhaps our greater concern is not duplicating research; it is doing research.

The Chairman: Filling the gaps.

Mr. Cope: That is right; I think that our research in transportation is years and years behind. I would not be too upset as a taxpayer if suddenly I found some research work was being duplicated, it might mean that we were at least catching up in some way or other.

Senator Robichaud: I will give you an example. Take number 13:

> An analysis of airline pricing for passenger services within, into and out of Canada.

Now, would all this not be done, say, by Air Canada? It seems to me they could not

operate efficiently unless they had made this kind of study.

Senator Grosart: They may not be coming up with the right answers.

Mr. Cope: I think that in this particular area the goals of Air Canada and the goals of the government of Canada might not necessarily be coincident, just as the goals of Canadian National and the goals of the government of Canada are not necessarily the same. Canadian National and Canadian Pacific, for example, might want to eliminate all their branch lines; they might want to move up the rate on Crowsnest grain; they might want to abandon passenger services. I do not think that in this area the goals of the Government are necessarily the same.

The same thing applies with the airlines; I think that Air Canada's pricing policy might not be the kind of pricing policy that the government of Canada wants.

Senator Hays: Mr. Cope, back in 1925 we had a chap by the name of Slim Moorehouse who drove 36 horses and pulled ten wagons hauling 2,200 bushels of grain and he did it twice a day.

You are talking about moving grain; I have two tractors on my farm, both of which cost over $13,000; they are sitting idle and there is nobody that I have been able to get interested in putting together cheap wagons where I can haul grain instead of a quarter a cent a bushel a mile, cutting this down by 300 or 400 per cent.

We are taking out railroad lines where we could be using these to move grain, and so on. There is lots of research that can be done on this sort of thing. You know as well as I do where you should be moving three or four thousand bushels of grain; at the same time we could load it on, we do not have to shovel it; who would you go to and see somebody who would do some research on this? It seems to me that you need some farmers instead of Ph.D.'s to replace some of these people.

Mr. Cope: I think that right now I look to the universities in the three western provinces to initiate or to handle that kind of thing.

Senator Hays: The universities are not having the problems; it is the farmer who is having the problems. He knows what kind of things can be done and it is very difficult to get anybody that is interested to build a wagon.

You see these trucks that are hauling a thousand bushels of grain today cost about $18,000 and at the same time we built four-wheel drive tractors that travel 15 and 16 miles and hour that might just as well be pulling seven or eight wagons, but we just do not have anybody that is doing this sort of research, to move this more economically, which it is quite possible to do.

Mr. Cope: Well, I think the idea is a most interesting one; what I was saying before is that we are right now trying to get the University of Manitoba working on the problem of the short transportation haul of grain. They have completed some work on the costs of moving grain by rail on the one hand versus truck on the other. It may be that they should be looking at other possibilities, along the lines that you suggest.

Senator Hays: To replace both?

Mr. Cope: That is right.

Senator Hays: Indeed we can replace both; we have a machine delivering in any event and you cannot deliver all your grain today. We deliver our grain at the rate of a bushel per acre on a quota basis, so you have these machines. The wheat year starts on the 31st of July and we make this delivery; we cannot move more than 600,000 bushels, so much a month. So when they phone you and say we will take another bushel, say you have a fairly big operation, you have got about 3,000 bushels to move. Then you start hiring trucks and you would have this equipment sitting right there. These wagons should not cost more than about $300 apiece, and you could move the whole thing, but you just cannot get people interested; they look right through you when you suggest why do you not build some of these wagons for us and then we will go to the Highways Board to see if we can move it, because we can use the same braking and all this sort of thing.

It is the same as moving cattle; the same equipment can be used for moving cattle. For instance, when I want to move 300 steers I have to hire a whole fleet of trucks and I could move them myself. Our neighbours can get together and we can move one another's grain, but it just looks as though you cannot get anybody interested in this sort of research, and these are very real things.

Mr. Cope: You have got me interested as a starter; I think that perhaps this is the kind of thing that this long term system study I

spoke of a few minutes ago might bring to the surface. It may be that if there are not sufficient entrepreneural initiatives there right now that some kind of incentive should be developed to bring it along, to encourage it. Maybe it is a better way to subsidize this to some extent than to underwrite the losses or the costs of sustaining some other forms of transport that may not be the most efficient.

The Chairman: I think that Mr. Cope has apparently been impressed by your very practical suggestion; do you want to pursue this any further?

Senator Hays: I just think that we are not talking about millions of dollars; we are talking about $10,000, but to the farmer—

The Chairman: It is too small.

Senator Hays: But to the farmer, you see we have areas now where these can be financed through the machinery syndicates bill very recently put into effect, but a little farmer cannot do this sort of thing. It is just possible; it just does not take any time to do this sort of research, but then you run into several problems. One is that a fellow says I do not want ten wagons on the road, but back in 1925 we had them. I saw this fellow drive horses around the block with 36 teams all by himself with a jerk bonnet and 2,000 bushels of wheat. At that time they were shovelling it by hand and they were hauling it 15 miles and they were doing it with horses; there is no vehicle today that is hauling as much as we were back in 1925.

Mr. Cope: Well, I will certainly take note of your suggestion; it seems eminently interesting and sensible to me, but I think the same kind of problem exists in the container field. We do not have Canadians coming forward, or Americans for that matter, and saying I want to build and own containers. Those who have taken an initiative on owning containers have been the shipping lines; they have had to do this for survival purposes. One decided to move ahead and use containers for certain ocean traffic and they have all had to follow, because there are certain economies, certain efficiencies, prevention of loss and damage, that has appealed to some of their customers, so they have entered it in a small way.

In North America if we were to ever start using the container system as opposed to the boxcar, or as opposed to the piggyback, for the movement of freight generally, you would need millions of containers. It is a huge business, but you find few people coming forward and saying that is the business they want to be in.

The Chairman: You are aware, I am sure, that some people at present are proposing that there should be a transportation research institute or council. How would this proposal fit in with your own exercise?

Mr. Cope: I am aware of some of the suggestions that have come forward in this area. Tillo Kuhn at York University has been talking of the development of a transportation research centre.

The Chairman: The CNR people yesterday proposed that to us also.

Mr. Cope: Yes; I know they have had that on their minds. Going back to the mid-fifties I think the Canadian National first started talking along those lines.

I think a problem in this area has been the resources that you can devote in the transportation area. You just cannot have too many centres of excellence; there are just not enough trained economists, engineers, sociologists or mathematicians to staff up all of the areas. I think that this would be a very practical problem right now; I think that you could say there is much to be said for a transportation centre that was independent of any authority, that did not look to the Minister of Transport, that did not look to the President of Canadian National or the President of the Canadian Transport Commission and could thus do some independent research. I think that this would be very interesting and we have tried to look at all the possibilities and encourage them in some way over the years, but there has really been insufficient effective initiative in this particular area.

If you can get a little bit of money together there has been no personnel to operate it; if there were a few personnel that were looking for new opportunities, the money was not there. These two have never come together.

Right now I think that there are probably too few trained people in Canada that could be found to make a centre of this kind work. I think as an alternative we could promote much of this through the Canadian Transport Commission, either through grants to universities, either in relation to their academic programs, on special contracts; we could bring university personnel into the Commission for a year on a sabbatical; they would go back to

the universities and we could get an interchange of ideas working in that way.

I think there are a number of things that we might practically do, but I am certainly not against a research centre; I would just wonder where the personnel would be found for it.

Senator Grosart: Mr. Cope, I said I would refer back to Sections 6 and 7(4) of the Act; this is the one that sets up your position as vice-president. You do not really need to answer this if you do not feel inclined to, but I seem to see a limitation, a very serious limitation on the research division in the reference there to programs of study and research necessary to achieve the objectives in Section 1. Section 1 seems to me to completely limit research. I will not go into the detail of it; I will just leave that as an observation. It confines the objectives of the Commission to certain conditions, which are pretty limited. To take Section 1 (a), for example, it requires the Commission to set up conditions under which all transport media will compete freely. Maybe an independent study might say it is a good thing not to have them compete freely; the same applies to (a), (b) (c) and (d).

Perhaps I can make this specific by asking you this question: Would all your reports be made to the minister; if so, will they be public property, will they be available to anybody other than the minister, or can the minister suppress them if he wishes?

Mr. Cope: It is our general goal to publish all of our research studies and they will be available to anybody at any nominal price that the Queen's Printer might set on the publication. There may be some studies that to not fall into this category, but I would say that the vast majority of them will be public knowledge.

On this question of the limitations to the work of the research unit I would suggest that Section 1 perhaps does not limit our research as much as it widens it. It focuses on a total transportation system making the best use of all available modes of transportation at the lowest total cost and that it will be economic, efficient and adequate. It seems to me our research to meet these broad criteria is very wide.

In addition to Section 1, Section 7(4) also refers to the . . .

Senator Grosart: To Section 15.

Mr. Cope: To the performance by the Commission of its duties under Section 15.

The Chairman: Section 15 is very wide.

Senator Grosart: But throughout Section 15 there is this limitation to report to the minister: (a) is report to the minister; (c) is report to the minister. We have seen this happen before, that this has been used to keep reports away from the public and I cannot see where if you are required by an act of parliament to report to the minister you can publish that document without his permission or to do what you say you will do, just turn them over to the Queen's Printer and say print them, the way the Economic Council does.

This is the point I was raising earlier.

The Chairman: In so far as the Economic Council is concerned, there is specific provision in the Act which authorizes the council to publish without reporting to the minister.

Senator Grosart: I think you were very wise to write that into the Act, Mr. Chairman.

The Chairman: I did.

Senator Grosart: Yes. I say you were very wise to write that into the Act. It is not written in here; that is why I raise this question as to whether this kind of total research, independent research that is so desperately necessary can be performed under what I say are the limitations under the Act. It so often happens that an Act like this is written and everybody says this is fine, let us get started; I do not object to that, but along the way we find these acts used more to restrict than to expand the authority given under the Act.

I am not going to ask you to comment, because we are really into policy here, unless you wish to, but I do not want to pin you down to either an interpretation of the Act or a policy statement; I just make this as an observation.

Mr. Cope: I think the government through its respective ministers of transport in recent years have indicated that it was their intention to publish reports of the Research Division of the Canadian Transport Commission.

Senator Grosart: Yes, but take the CN: how many times has the CN refused to give information to a parliamentary committee. It happened only the other day in a very important area where Members of Parliament asked for

the balance sheet of the Newfoundland railway, and the CNR said we will not give it to you?

I would hope that in this case anybody who was interested might say we will go to this independent Research Division and ask them to get the facts for us. Are we going to run into the same thing, we can only report to the Minister of Transport? This is my concern; I wish you well. I hope it works out, but I see these dangers.

Mr. Cope: I understand your point; I can comment no further.

Senator Grosart: No, I do not want you to.

The Chairman: Are there any other questions? It seems to me that the Commission will have perhaps a lot of problems and potential conflicts with the Department of Transport when you look at all these duties which are defined in Section 15 of the Act. Section (a), for instance, says "inquire into and report to the minister upon measures to assist in a sound economic development of the various modes of transport over which parliament has jurisdiction."

Surely the people in the Department of Transport, if they are to do something, ought to do this, but again I suppose that this is an unfair comment at this stage to make to you, because you are not responsible for the Act.

Mr. Cope: I will go back to the earlier point though. It seems to me clear that any wise operator of any business has to undertake research in respect of his business. The Department of Transport is in the business of building and operating airports.

The Chairman: And advising the minister on transportation policy, I presume.

Senator Grosart: Who is going to say that they made a mess of X airport?

Senator Robichaud: Put on the wrong surfacing, for example, as they have done in many cases.

Senator Grosart: I will not go into details, but who is going to tell us that the policy of building this airport here, or the Montreal airport without a level escalator was wrong?

Mr. Cope: I think that the focus of the Commission will be on making recommendations to see that that kind of problem does not recur.

Senator Grosart: May I just for the record say that I was not making a categorical statement that the policy in these airports was wrong; what I meant was if it was wrong. I was not saying it was; I am not making any comment on it.

Mr. Cope: I do not know that I should comment any further on that, because it is a very difficult one to deal with. I do not know that it would be a good idea for the Canadian Transport Commission to come along and say the National Harbours Board was wrong here, the Department of Transport was wrong in any of their planning. I think that a much better focus would be for us to suggest to these other agencies where we think that they can improve tomorrow. I think that this makes good sense.

Senator Cameron: You cannot undo what has been done.

The Chairman: We are told by several people that research should be undertaken as close as possible to where the policy decisions have to be made, and here we have an example of a huge program of research in the field of transportation getting away from the department and going into a Commission, the main function of which is regulation. It seems to me a little bit awkward in the family of research agencies within the federal Government.

Mr. Cope: We in the Commission tend to think of our responsibilities as extending to economic regulation, to policy formulation and advice and research to underpin either of these. I do not feel that the Department of Transport is the sole source of transportation policy advice to the minister. I think any minister is going to turn to all his advisers; he is going to turn to the Chairman of the National Harbours Board; the President of the St. Lawrence Seaway; the President of the Canadian National. All of these are policy advisers to the minister.

I think that it is certainly a convenient arrangement for the Canadian Transport Commission to pull together policy recommendations that flow right out of the research program that we have carried out.

Senator Grosart: I fully agree with you, Mr. Cope, that there is a very important function facing the Commission and the Department of Transport. There is no question about it, but the doubt in my mind is as to whether in fulfilling that function you can

fulfil the larger function of making an independent, impartial assessment of transportation policy and technology as it develops. That is the nub of my doubt.

The Chairman: When we look at the future plans for research in the Department of Transport and in the CNR, for instance, as compared with yours, it seems to me that you are getting ready now to become the real centre of research in the field of transportation in Canada in so far as at least the federal Government is concerned.

Mr. Cope: Yes sir; we feel that in doing so we are carrying out Parliament's instructions.

Senator Grosart: There is no doubt about that, if Parliament's instructions were wise.

The Chairman: We are just a little bit worried if Parliament was wise, the Queen can do no wrong.

I am quite sure that this line of questioning though is very unfair to our witness and I think would be unfair also even if Mr. Pickersgill were here.

Mr. Cope: I think we would get much more interesting answers where he here.

Senator Grosart: I am not so sure of that. I must compliment Mr. Cope; I think his answers have been excellent and, under the circumstances, very adequate.

The Chairman: On this very nice note from Senator Grosart, I think we might adjourn. We certainly want to thank you very much for spending this time with us. Perhaps when the President of the Commission reads the evidence he may express the wish to appear before us and answer some of these "unfair" questions—so we will perhaps hear from him. I am sure that if he expresses the desire to appear before this Committee he will be most welcome.

Senator Cameron: I think we shoud have him, Mr. Chairman; this is no reflection on Mr. Cope, but I think that there are quite a few things that we have not touched.

The Committee adjourned.

APPENDIX 21

BRIEF

of the

CANADIAN TRANSPORT COMMISSION

to the

SPECIAL SENATE COMMITTEE ON SCIENCE POLICY

Submitted by:

Hon. J.W. Pickersgill,
President,
Canadian Transport Commission.

Mr. R.R. Cope,
Commissioner, Research Division,
Canadian Transport Commission.

ConGill Building,
275 Slater Street,
Ottawa 4, Ontario.

October 22, 1968.

BRIEF OF THE CANADIAN TRANSPORT COMMISSION
TO THE SPECIAL SENATE COMMITTEE ON SCIENCE POLICY

ORGANIZATION

1. Exhibit No. 1 outlines the general organization of the Canadian Transport Commission. As can be noted, the Commission is organized to discharge two basic functions: the economic regulation of the transportation industry: and the undertaking and administration of the broad programme of research necessary to the maintenance of sound transportation policies and to the effective allocation of federal investment funds on transportation facilities.

2. The economic regulatory responsibilities of the Canadian Transport Commission are carried out through five committees under the general superintendence of one Vice-President. It might be noted here that fifteen of the Commission's seventeen Commissioners are primarily concerned with tasks in that area and function in a quasi-judicial capacity.

3. The Research Division, under the superintendence of the other Vice-President, administers the research programme. This Commissioner has no judicial powers and is not involved in the economic regulatory work of the Commission.

4. There are a large number of parties who influence the size, shape, and scope of the research programme. Included is the Minister of Transport, various departments and agencies of the federal government including, in particular, the Department of Transport and the National Research Council, and, of course, the Canadian Transport Commission, especially the Research Division, which is assisted by an Advisory Council on Research--a fifteen-man body of Canadians from non-government and non-transportation sectors of our society.

.....2

5. The President, as chief executive officer of the Commission, has responsibilities which extend over both economic regulation and research programs. On economic regulatory matters, the Commission acts in a quasi-judicial capacity independently of the government. On research and policy questions, the Commission generally acts as the advisor of the Minister of Transport or of the government. The Minister, himself, becomes involved in regulation only when appeals from decisions of the Canadian Transport Commission relating to certain types of licences or certificates are made to him, or when petitions are made to the Governor in Council for varying or rescinding orders, decisions, rules or regulations of the Commission.

ORGANIZATIONAL FUNCTIONS

6. The statutory functions of the Canadian Transport Commission as they concern scientific activities are set out in Section 15 of the National Transportation Act of 1967. This is reproduced here as Exhibit No. II.

7. The Canadian Transport Commission came into being in September 1967, and is, therefore, relatively new. The Research Division is even newer, the first appointment having been made in February 1968. Initial activity within the Research Division has been concerned with development of a programme and with the recruitment of professional staff to manage parts of the programme. Since September 1, five professionals have commenced work. Seven other professionals, all senior, have accepted positions and will be reporting at different dates up to February 1, 1969. It is planned to develop the Research Division to its full size of about forty professionals within the next thirty months.

8. Because of the newness of the Canadian Transport Commission to the area of scientific research, it is not possible to describe relationships with other government

bodies nor to give an historical account of the Canadian Transport Commission's research activities. A brief outline of the philosophy which will govern the development of the C.T.C. in this area, however, may be helpful.

9. Parliament has charged the Canadian Transport Commission with the responsibility for developing a strong research establishment to underpin the development of broad and consistent national transportation policies which will support the attainment of an economic, efficient, and adequate transportation system making the best use of all available modes of transportation at the lowest total cost. These goals require judgements not only in the scientific field, but economic, political and social judgements as well. The C.T.C.'s approach to the development of a research capability has, therefore, been predicated on the need to achieve an inter-disciplinary analysis of problems. The Research Division of the C.T.C. itself will thus be made up of economists, statisticians, geographers, physicists, mathematicians, engineers, and general arts graduates as well.

10. The passenger and freight transportation system of this country is both large and complex. It embraces a number of important sub-systems such as urban and inter-urban transportation systems, is made up of both publicly-owned and privately-owned components, and includes many different modes of transport such as airlines, railways, pipelines, motor carriers, motor coaches, automobiles, ships, submarines, air cushion vehicles, and conveyor systems. A federal programme of transportation research must, therefore, have breadth as well as depth.

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11. The research responsibilities of the Canadian Transport Commission will range from general economic or fundamental policy research to project research, both economic and technical. There is a variety of ways in which the C.T.C. might handle this programme but it will include combinations of in-house research, research undertaken by other departments and agencies of government, research undertaken by consultants and directed by the C.T.C. or other governmental agencies, research work undertaken within the universities as part of their academic programme, research work undertaken within the universities as special contract programmes, and research work undertaken by other transportation institutes of one kind or another.

12. Planning of the Research Division of the Canadian Transport Commission has attempted to take into account both the achievement of a desirable balance as between research work carried out "inside" and "outside" of the Commission, and the need to attain a critical "threshold of size" below which research efforts are usually so scattered and sporadic as to be unsuccessful. The basic research team of the Commission must, as suggested before, provide the inter-disciplinary dialogue earlier outlined in respect of a great number of transportation problems such as surface and sub-surface transportation in the far north, the development of large-scale integrated bulk transportation terminals, urban transportation planning and development, high-speed intercity passenger transportation, the horizontal or vertical integration of one transport company within the operations of another, the application

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of the linear induction motor to new vehicles of transportation, waterway creation and expansion, airport location, the development of harbours for large bulk carriers, and modern theories on transportation pricing and regulation, to name a few. It is believed that the critical threshold for the Commission's Research unit is of the order of 20 - 25 professionals. Below this size, there will be no hope of providing a continuity and consistency of effort to the many research problems facing the Commission. Research resources would be allocated wherever they were felt to be most needed, leaving a kind of vacuum in the area just vacated by the reallocated research resources. It is interesting to note that successful transportation consulting companies have recognized the fundamental truth involved here. It is not uncommon for a consulting company on a single large scale project, such as the study of the need to extend the Welland Canal, to involve 10 or 15 professionals to a greater or lesser degree. It is suggested that a number of transportation studies undertaken in the last ten year period have been awarded to transportation consultants merely because of their capacity to marshal the varied analytical skills required in a large scale project.

13. A major goal of the Canadian Transport Commission is to encourage universities to expand their programmes of transportation education and transportation research. Until the last few years, there has been very little attention paid in Canadian universities to studies in transportation, particularly with respect to transportation economics. As a result, there has been a marked lack of transportation educators and researchers in Canada.

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The C.T.C., for example, has had to look outside Canada for a large number of its senior research personnel. Transportation education and research programmes which have been started within the past few years in Canada, properly encouraged, will help to eliminate the deficiencies mentioned. The C.T.C. intends, therefore, to provide financial support for research fellowships for post graduate studies, financial assistance to university staff in undertaking transportation research work, and to enter into contractual arrangements with universities for specific research work where mutually agreeable.

14. The Canadian Transport Commission also intends to utilize consultants and, in fact, to encourage the development in Canada of the same kind of inter-disciplinary competence among transportation consultants as is planned for the Research Division itself. Too often, it is necessary to look outside of Canada for such competence at the present time, particularly where an economics capability is involved.

15. The Canadian Transport Commission will also be looking to the National Research Council and other agencies of the federal government for assistance with some parts of the research programme. The N.R.C. is seen as being a natural partner to the C.T.C.'s Research Division. The Research Division's efforts would be focused on establishing what types of transportation technology should be studied and tested, whereas the N.R.C.'s efforts would be primarily directed towards developing the testing programmes themselves. For example, if the C.T.C. felt that there was merit in establishing

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in Ottawa a solids pipeline research facility and studying the transmission through pipeline of different products, the N.R.C. would seem to be the logical body to carry out the work. Study of the application of air cushion technology to passenger trains would also involve a partnership between the C.T.C.'s Research Division and the N.R.C.

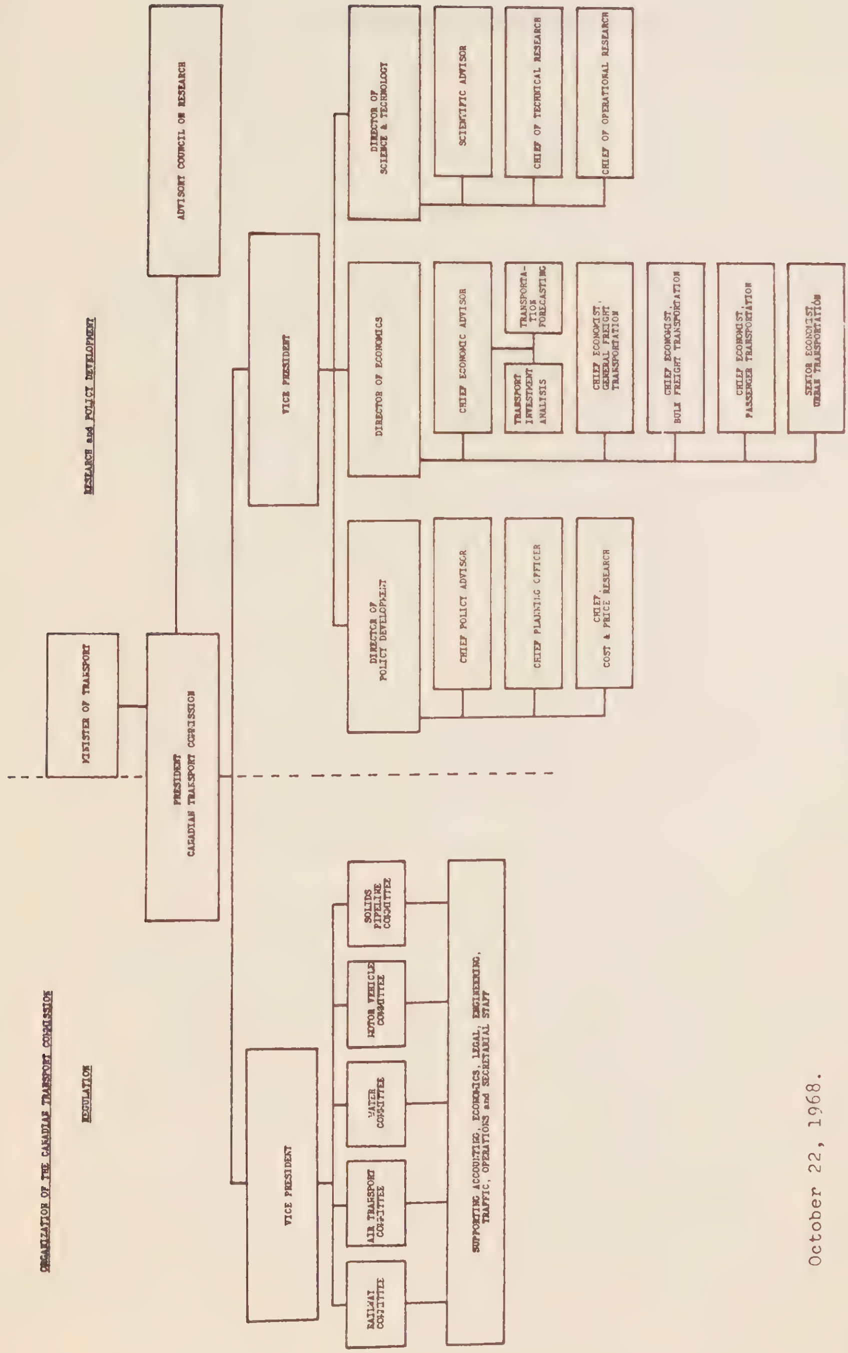
16. Planning of the research programme, consideration of research priorities, and decision as to how the research programme is to be carried out are areas for consideration and recommendation by the Advisory Council on Research. The Council will meet on three or four occasions each year to consider and advise on the research programme of the Canadian Transport Commission and to help formulate policies and programmes of assistance to universities.

17. The foregoing summarizes the background of thinking and planning that has gone into the development of the Canadian Transport Commission's research programme and staffing thus far. The foundation for planning and managing a research programme is thus to be more comprehensive than ever before, and it is believed that through this approach it will be possible to overcome much of the existing inadequacies in scientific research on transportation problems. A copy of the initial programme of research of the C.T.C. is attached as Exhibit III.

October 22, 1968.

Exhibit I

ORGANIZATION OF THE CANADIAN TRANSPORT COMMISSION



October 22, 1968.

Exhibit II

Excerpt from the National Transportation Act

PART I

CANADIAN TRANSPORT COMMISSION

Powers and Duties

"15. (1) In addition to its powers, duties and functions under the Railway Act, the Aeronautics Act and the Transport Act, the Commission shall

(a) inquire into and report to the Minister upon measures to assist in a sound economic development of the various modes of transport over which Parliament has jurisdiction;

(b) undertake studies and research into the economic aspects of all modes of transport within, into or from Canada;

(c) inquire into and report to the Minister on the relationship between the various modes of transport within, into and from Canada and upon the measures that should be adopted in order to achieve co-ordination in development, regulation and control of the various modes of transport;

(d) perform, in addition to its duties under this Act, such other duties as may, from time to time, be imposed by law on the Commission in respect of any mode of transport in Canada, including the regulation and licensing of any such mode of transport, control over rates and tariffs and the administration of subsidies voted by Parliament for any such mode of transport;

(e) inquire into and report to the Minister upon possible financial measures required for direct assistance to any mode of transport and the method of administration of any measures that may be approved;

(f) inquire into and recommend to the Minister from time to time such economic policies and measures as it considers necessary and desirable relating to the operation of the Canadian merchant marine, commensurate with Canadian maritime needs;

(g) establish general economic standards and criteria to be used in the determination of federal investment in equipment and facilities as between various modes of transport and within individual modes of transport and in the determination of desirable financial returns therefrom;

(h) inquire into and advise the government on the overall balance between expenditure programs of government departments or agencies for the provision of transport facilities and equipment in various modes of transport, and on measures to develop revenue from the use of transport facilities provided or operated by any government department or agency; and

(i) participate in the economic aspects of the work of intergovernmental, national or international organizations dealing with any form of transport under the jurisdiction of Parliament, and investigate, examine and report on the economic effects and requirements resulting from participation in or ratification of international agreements.

(2) The Commission may examine into, ascertain and keep records of, and make appropriate reports to the Minister on,

(a) the shipping services between Canadian ports and from ports in Canada to ports outside Canada that are required for the proper maintenance and furtherance of the domestic and external trade of Canada;

(b) the type, size, speed and other requirements of the vessels that are and in the opinion of the Commission should be employed in such services;

(c) the cost of marine insurance, maintenance and repairs, and wages and subsistence of officers and crews and all other items of expense in the operation of vessels under Canadian registry and the comparison thereof with similar vessels operated under other registry;

(d) the water transportation industry and undertakings and services directly related thereto;

(e) the terms, conditions and usages applying to transportation of goods and passengers by water within, into and from Canada;

(f) the work of international and intergovernmental organizations and agencies that concern themselves with the transportation of goods and passengers by water; and

(g) such other marine matters as the Minister may request or as the Commission may deem necessary for carrying out any of the provisions or purposes of this Act.

(3) The Commission shall

(a) exercise and perform on behalf of the Minister such powers, duties or functions of the Minister under the Canada Shipping Act as the Minister may require; and

(b) exercise and perform any other powers, duties or functions in relation to water transport conferred on or required to be performed by the Commission by or pursuant to any other Act or any order of the Governor in Council.

(4) In carrying out its duties and functions under this section, the Commission may consult with persons, organizations and authorities that in the opinion of the Commission are in a position to assist the Commission in formulating and recommending policy and the Commission may appoint and consult with committees being representative of such persons, organizations and authorities.

(5) The Commission may delegate, in whole or in part, to any other body or authority subject to the legislative authority of the Parliament of Canada any of the powers or

duties of the Commission in respect of safety in the operation of commodity pipelines and such delegated body or authority may exercise and shall perform the powers or duties so delegated.

(6) Where a person who transports goods by a mode of transport other than rail charges a toll, expressed as a single sum, for the carriage of traffic partly by one mode of transport and partly by a different mode of transport, the Commission, for the purpose of determining whether a toll charged is contrary to any Act of the Parliament of Canada, may require such person to declare forthwith to the Commission, or may determine, what portion of such single sum is charged in respect of the carriage of traffic by the mode of transport by which such person transports goods."

EXHIBIT III

INITIAL CANADIAN TRANSPORT COMMISSION RESEARCH PROGRAMME
AS APPROVED BY THE ADVISORY COUNCIL ON RESEARCH
IN OTTAWA ON JUNE 10 AND 11, 1968.

1. A comprehensive review of national transportation statistics with a view to increasing their completeness and usefulness as tools for economic analysis, inter-modal regional and international comparisons and for allocation of transportation resources, particularly investment funds. Particular study to be given to development of adequate cargo flow data. Consideration also to be given to the possible future development of a transportation data bank.
2. A study of a Canadian deep-sea merchant marine commensurate with Canadian maritime needs.
3. Development of the general economic standards, criteria and procedures which are to be used in the determination of federal investment in equipment and facilities as between various modes of transport and within individual modes of transport and in the determination of desirable financial returns therefrom.
4. A preliminary study to consider the feasibility of developing specific criteria for assessing whether a transportation system is economic, efficient, or adequate, and the development of working definitions for those terms.
5. The development of techniques for forecasting transportation demand for both public and private services, for all transportation (air, marine, submarine, surface, and pipeline) and for both passenger and goods traffic, domestically and internationally. Study to be given to the implications of population changes for transport systems, (e.g. rural urban shift and resulting high density urban movements, and low traffic density rural problems, with particular

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attention to the overall rate of growth. Study also to be given to the application of the input/output techniques to the forecasting of freight transportation requirements.

6. Study of the potential for container operations into, across, and out of Canada with particular emphasis on the land bridge and an assessment of development requirements. The study to be advanced as practical pending development of an adequate cargo flow data base.
7. Initiation of a series of studies which would evaluate the impact of specific new transport technology and its implications for the development of transportation to include containerization, hovercraft, solids pipelines, unit trains, newer types of aircraft, jets and supersonics, icebreaking techniques, nuclear submarines, monorail systems, air cushion train operations, and new forms of urban transport systems such as the teletrans system, STARRcars, automated jitney services, skybus, and other proposals of that type.
8. A study as to the future of the movement of both bulk commodities and general cargo moving to and from the Great Lakes via the St. Lawrence Seaway system, having regard to the feasibility of developing certain new rail services as an alternative to some shipping services.
9. Development of a methodological framework for assessing regional transportation needs.
10. A general study of ports and harbours administration in Canada.
11. A preliminary review of the status, extent and nature of urban transportation planning in Canada.
12. Establishing criteria with respect to profitability as an aid to economic regulation, i.e. with respect to rate control and entry control.

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13. An analysis of airline pricing for passenger services within, into and out of Canada.
14. A study of railway car supply and the relationships of an adequate supply to the development of natural resources.
15. A study to examine our approach to the development of bilateral agreements and mechanisms by which such agreements can be amended without delay when required.
16. A study to determine what further requirements exist for co-ordination of the transportation policies of the various levels of government and how such co-ordination might be brought about.
17. Development of a post audit system for evaluating the results of government capital investments in the transportation area.
18. A study to determine the costs, revenues, and benefits of transportation resources, facilities and services provided wholly or partly at public expense, whether at the municipal, provincial or federal level, or at a combination of levels.
19. A review of the appropriateness of existing measures to develop revenue from the use of transportation resources, facilities, or services provided wholly or partly at public expense.
20. A study of the effect of the subsidization of a mode (or modes) of transportation on the rates charged by that mode and on its relative profitability.
21. A study of the differences between the grain handling and transportation techniques of the United States, Australia and Canada.

October 22, 1968.

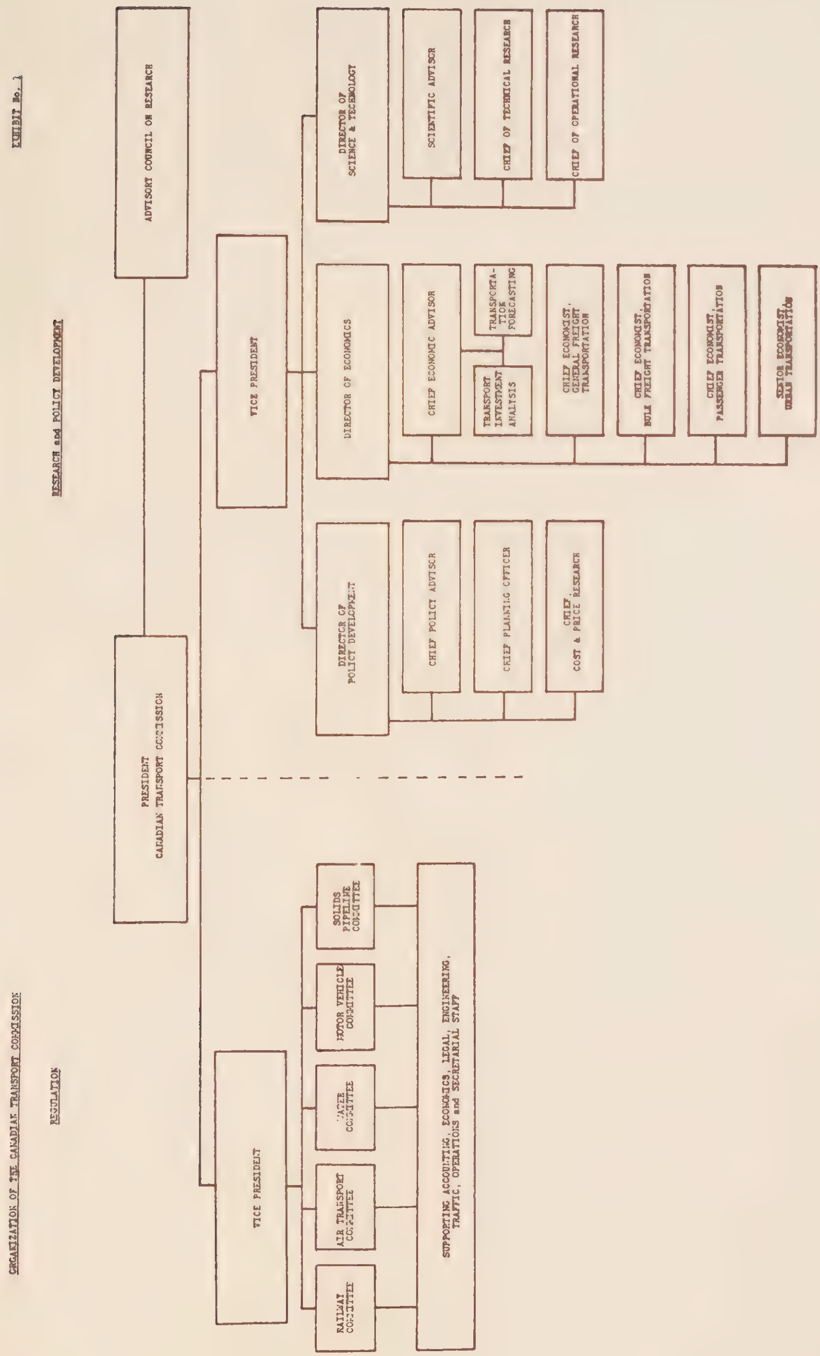
EXHIBIT No. 1
ORGANIZATION OF THE CANADIAN TRANSPORT COMMISSION
RESEARCH and POLICY DEVELOPMENT
REGULATION
ADVISORY COUNCIL ON RESEARCH
PRESIDENT CANADIAN TRANSPORT COMMISSION
VICE PRESIDENT
DIRECTOR OF SCIENCE & TECHNOLOGY
SCIENTIFIC ADVISOR
CHIEF OF TECHNICAL RESEARCH
CHIEF OF OPERATIONAL RESEARCH
DIRECTOR OF ECONOMICS
CHIEF ECONOMIC ADVISOR
TRANSPORTATION FORECASTING
TRANSPORT INVESTMENT ANALYSIS
CHIEF ECONOMIST, GENERAL FREIGHT TRANSPORTATION
CHIEF ECONOMIST, BULK FREIGHT TRANSPORTATION
CHIEF ECONOMIST, PASSENGER TRANSPORTATION
SENIOR ECONOMIST, URBAN TRANSPORTATION
DIRECTOR OF POLICY DEVELOPMENT
CHIEF POLICY ADVISOR
CHIEF PLANNING OFFICER
CHIEF, COST & PRICE RESEARCH
VICE PRESIDENT
RAILWAY COMMITTEE
AIR TRANSPORT COMMITTEE
WATER COMMITTEE
MOTOR VEHICLE COMMITTEE
SOLIDS PIPELINE COMMITTEE
SUPPORTING ACCOUNTING, ECONOMICS, LEGAL, ENGINEERING, TRAFFIC, OPERATIONS and SECRETARIAL STAFF